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ABSTRACT

This research paper explores the relationship between fertility and the investments made by parents in the schooling of their children in Cote d'Ivoire and Ghana (both in Africa). The tendency in developing nations research is that families with many children invest less in each, and families with fewer children make greater human capital investments per child. The two papers in this volume examine the determinants of fertility and child schooling in Cote d'Ivoire and Ghana to assess evidence of a tradeoff between the number of children born and levels of child schooling. In Cote d'Ivoire, there is evidence of such a tradeoff in urban areas, but not in rural areas. Female schooling, higher income, and improved child survival are associated with lower fertility and higher child schooling. In both urban and rural areas of Ghana, there is evidence of a tradeoff between fertility and child schooling with higher incomes and, in rural Ghana, with increases in mothers' schooling. The papers in this monograph include: (1) "Fertility and Child Schooling in Cote d'Ivoire: Is There a Tradeoff?" (Mark Montgomery; Aka Kouame); and (2) "Fertility and Child Schooling in Ghana: Evidence of a Quality/Quantity Tradeoff" (Raylynn Oliver). Contains 18 references. (EH)

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LSMS

Living Standards
Measurement Study
Working Paper No. 112

The Tradeoff between Number of Children and Child Schooling

Evidence from Côte d'Ivoire and Ghana

Mark Montgomery
Aka Kouamé
Raylynn Oliver

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The Tradeoff between Number of Children and Child Schooling

Evidence from Côte d'Ivoire and Ghana

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LSMS Working Paper
Number 112

The Tradeoff between Number of Children and Child Schooling

Evidence from Côte d'Ivoire and Ghana

Mark Montgomery
Aka Kouamé
Raylynn Oliver

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Mark Montgomery is a research associate at the Population Council and an associate professor of economics at the State University of New York, Stony Brook. Aka Kouamé is a lecturer and research coordinator at the Institute for Demographic Training and Research (IFORD) in Yaoundé, Cameroon. Raylynn Oliver is a consultant to the Africa Technical Department of the World Bank.

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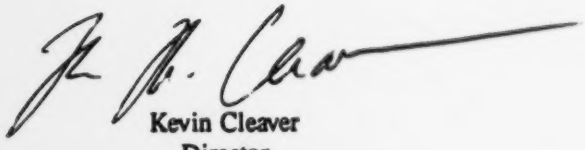
Paper Number 2: "Fertility and Child Schooling in Ghana: Evidence of a Quality/Quantity Tradeoff" by Raylynn Oliver 71

Foreword

A well known feature of fertility declines in many developing countries is that parents begin to have fewer children but invest more in the health, education, and support of each child. The factors that induce parents to realize this "tradeoff" is of great policy interest, since they simultaneously encourage slower population growth and higher quality of population. The two papers in this volume examine the determinants of fertility and of child schooling in Côte d'Ivoire and Ghana to assess evidence of a tradeoff between the number of children born and levels of child schooling. In Côte d'Ivoire, there is evidence of such a tradeoff in urban areas, but not in rural areas. Female schooling, higher income, and improved child survival are associated with lower fertility and higher child schooling. In both urban and rural areas of Ghana, there is evidence of a tradeoff between fertility and child schooling with higher incomes and, in rural Ghana, with increases in mothers' schooling.

These papers are two of several products of the World Bank research project on "The Economic and Policy Determinants of Fertility in Sub-Saharan Africa", sponsored by the Poverty and Human Resources Division of the Africa Technical Department (AFTHR) and managed by Martha Ainsworth, principal investigator. It is part of a broader research effort in the Poverty and Human Resources Division of the Policy Research Department (PRDPH) that examines the role of human resources in economic development. The data used are from the Côte d'Ivoire and Ghana Living Standards Surveys, which are two of many Living Standards Measurement Study (LSMS) household surveys implemented in developing countries with the assistance of the World Bank.



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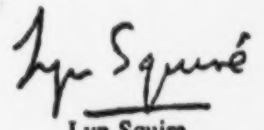

Lyn Squire
Director
Policy Research Department

Paper Number 1

Fertility and Child Schooling in Côte d'Ivoire: Is There a Tradeoff?

Mark R. Montgomery
Aka Kouamé

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Abstract

This research explores the relationship in Côte d'Ivoire between fertility and the investments made by parents in the schooling of their children. One expects that families with many children will tend to invest less in each, and that families with fewer children will make greater human capital investments per child. The "tradeoff" of quantity for quality is vividly illustrated in the recent economic development of Southeast Asia and Latin America. In respect to Sub-Saharan Africa, however, the existence of a tradeoff has not yet been established. The few studies conducted to date either suggest no particular association between family size and schooling in Africa, or hint at a positive relationship wherein higher fertility is linked to greater schooling per child. This paper weighs the evidence concerning the quantity-quality tradeoff in Côte d'Ivoire, using data drawn from the three rounds of the Côte d'Ivoire Living Standards Measurement Survey (LSMS) conducted from 1985 to 1987.

The evidence suggests that two very different relationships link fertility and child schooling. In the rural areas of Côte d'Ivoire, there is no tradeoff: higher fertility is associated with higher child schooling. This finding is consistent with much of the early research on fertility and schooling in Africa. Urban areas, by contrast, are characterized by the tradeoff that appears in Southeast Asia and elsewhere in the developing world. Female education, which lowers fertility and raises investments in child schooling, is an important factor producing the tradeoff in urban areas, and the results also imply that improved child survival may be important. One possible explanation for the absence of a tradeoff in rural areas is less access to family planning services, which are available from private sources in urban areas.

Acknowledgments

This paper was prepared for the research project on "The Economic and Policy Determinants of Fertility in Sub-Saharan Africa." The authors are, respectively, Associate Professor of Economics, SUNY-Stony Brook, and Assistant Professor, Institut de Formation et de Recherche Demographiques. We would like to thank Martha Ainsworth, Paul Glewwe, Hannan Jacoby, Tom LeGrand, Robert Prouty and participants in Stony Brook's Applied Workshop in Econometrics for helpful comments. We would also like to acknowledge with appreciation the Institut National de la Statistique of Côte d'Ivoire for assistance in linking census variables to the household data set. The opinions expressed in this paper are those of the authors and do not necessarily reflect policy of the World Bank or its members.

Introduction

This research explores the relationship between fertility in Côte d'Ivoire and the investments made by parents in the schooling of their children. One expects that families with many children will tend to invest less in each, and that families with fewer children will make greater investments per child. This negative association between fertility and human capital investment per child, evident in economies as diverse as those of the United States (Hanushek, 1992) and Thailand (Knodel et al., 1987, 1990), has been termed the "quantity-quality tradeoff." The tradeoff is so ubiquitous as to seem one of the stylized facts of economic development. Yet at present, it is not at all clear that a quantity-quality tradeoff exists in Sub-Saharan Africa. The few studies conducted to date (DeLancey, 1990) either suggest no particular association between family size and schooling in Africa, or hint at a positive relationship wherein higher fertility is linked to greater schooling per child. In this paper we will weigh the evidence concerning the quantity-quality tradeoff in Côte d'Ivoire, using data drawn from the three rounds of the Côte d'Ivoire Living Standards Measurement Survey (LSMS) conducted in 1985 to 1987.

We should begin by emphasizing the importance of the quantity-quality tradeoff to the prospects for long term economic growth. In Côte d'Ivoire as elsewhere in Africa, fertility levels will likely remain the principal determinant of the future rate of labor force growth. The human capital invested in children will be the principal determinant of the skills possessed by that labor force.[1] Moreover — and this is particularly clear for women — the levels of schooling attained by the current cohort of children will shape their future fertility and influence the health and survivorship of the next generation of children (Benefo and Schultz, 1992).

Aggregate, cross-national data show a clear tradeoff between quantity and quality, as is evident in Figures 1 and 2. The figures present data from all developing countries with per capita income levels of $3000 and below in 1989. Total fertility rates are arrayed on the vertical axes; primary and secondary gross enrollment levels are placed along the horizontal. The countries of Sub-Saharan Africa (SSA) are distinguished in the diagrams from their counterparts elsewhere. A regression line provides a descriptive summary of the relationship.

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1. A small body of research seeks to quantify the economic benefits of schooling through the estimation of aggregate production functions; see Glewwe (1991) who cites work of Lau, Jamison and Louat in this regard. This work suggests that in Latin America and East Asia, an increase of one year in average adult educational attainment is associated with an increase of some 3-5 percent in real GDP. Curiously, however, no such beneficial effect is detectable in aggregate data for Sub-Saharan Africa. Individual-level data for African populations usually show a strong association between education and incomes in urban areas (some of this may be due to credentialism rather than to real productivity enhancement) and weak or mixed results in rural areas.

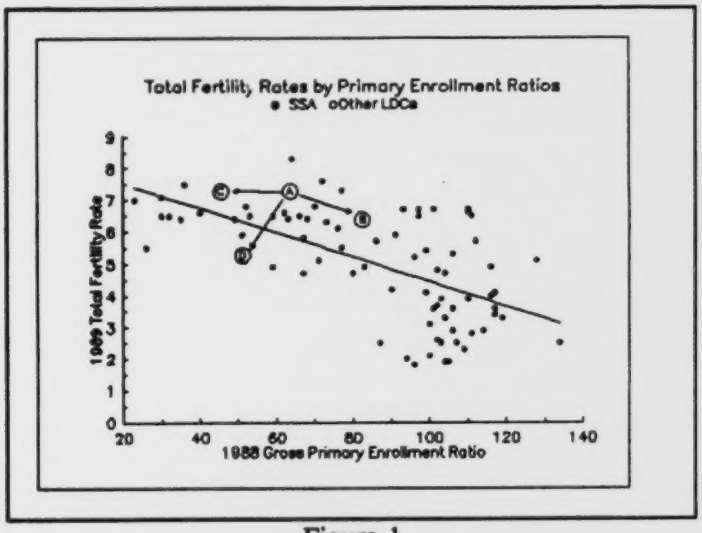

Figure 1
Source: *1991 World Development Indicators.*

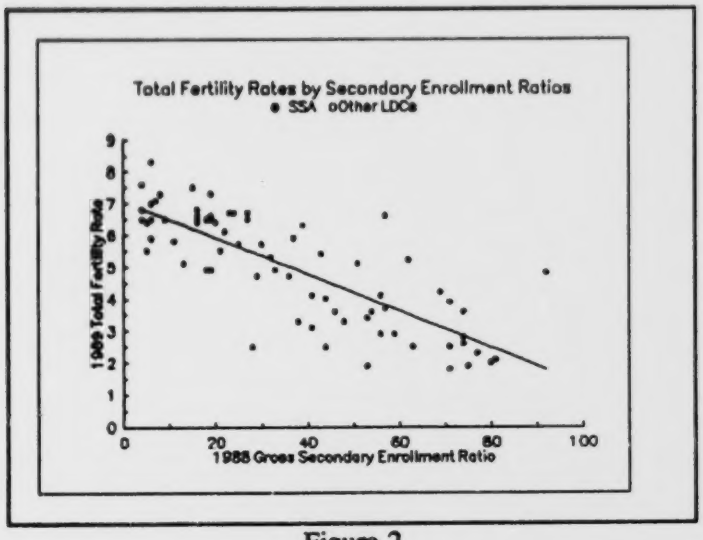

Figure 2
Source: *1991 World Development Indicators.*

In these figures, quantity (fertility) and quality (child schooling) should be regarded as being endogenous in nature. That is, both fertility and schooling reflect choices made by households that are set in economic environments shaped by markets and by government policies. A set of exogenous background factors therefore determines each country's location in the dimensions of quantity and quality. The exogenous factors include the level of income per capita in the country in question, its degree of urbanization, the extent of adult educational attainment, and the probabilities of child survival; they also encompass an array of country-specific policies regarding educational pricing, infrastructure and family planning service delivery. The quantity-quality tradeoff itself represents a systematic association between two endogenous variables, an association that has its origins in fundamental exogenous determinants of household behavior.

As can be seen in Figures 1 and 2, taking all developing countries under consideration, there exists a strong negative association between fertility and human capital investment in children. But it is also apparent that in Sub-Saharan Africa, the tradeoff between quantity and quality is weaker than elsewhere, if indeed it exists at all. The slope of the relationship between fertility and primary enrollment rates in the Sub-Saharan countries (Figure 1) is negative but negligible, and although a steeper slope is evident in respect to fertility and secondary school enrollment (Figure 2) and African countries seem to cluster about the regression line, secondary enrollments in most African countries remain low.

Consider the development prospects facing a country that begins in position A of Figure 1. One potential path of development is represented in a movement from point A to point B, whereby a reduction in future labor force growth is accompanied by an increase in human capital per worker. This is the kind of quantity-quality transition that has been in progress in Southeast Asia (see Knodel et al., 1987,1990) and Latin America. Is such a path achievable for African countries? Or given the developments of the 1980s, are the directions indicated by points C and D now more likely?

Lesthaeghe (1989) has raised the possibility of a "crisis-led" demographic transition in Africa in connection with the economic conditions of the past decade. Incomes per capita have declined in many African countries, and this has been coupled with increases in the exogenous costs of child-rearing, most notably in regard to the private costs of schooling (Makinwa-Adebusoye, 1991). The combination of income and price effects may result in fertility decline accompanied by a decline in school enrollments, as indicated in movement to point D of Figure 1, or may leave fertility essentially unchanged while enrollments are reduced (point A to point C). The prospects for long term economic growth implicit in these development paths are profoundly different from what is implied in a quantity-quality transition (A to B).

Côte d'Ivoire presents an interesting case study of these issues. After a long post-Independence period of steady growth, the economy of Côte d'Ivoire was unsettled in the early 1980s by a series of brutal external shocks, particularly in the cocoa and coffee markets. A growing burden of debt and continued high population growth further undermined the situation, such that by 1987 (see Figure 3), GDP per capita had fallen by some 22 percent from a 1978 high point of $1345. The decade was also marked by

reductions in per capita government spending in the education and health sectors (also shown in Figure 3). In an analysis of capital budgets, Russell and Stanley warned that as of 1988:

> It appears that investment in the education sector has been cut about as far as it can be. In fact, the low level of investment in education risks degradation of the system [Russell and Stanley, 1988:ix]

Yet in recurrent-expenditure terms, Côte d'Ivoire continued to allocate as much as 50 percent of its central government budget to education and health (World Bank, 1990b:5), seemingly without a commensurate payoff in educational performance. Kenya, for instance, enjoys perhaps half the GNP per capita of Côte d'Ivoire, and spends less than 30 percent of its budget on education and health (World Bank, 1990b:6). Yet Kenya achieved nearly universal primary enrollment as of 1989 (94 percent), whereas in 1985 Côte d'Ivoire's primary enrollment ratio stood at only 75 percent (males 88 percent, females 62), a figure that may even have declined slightly over the decade (see Figure 4).

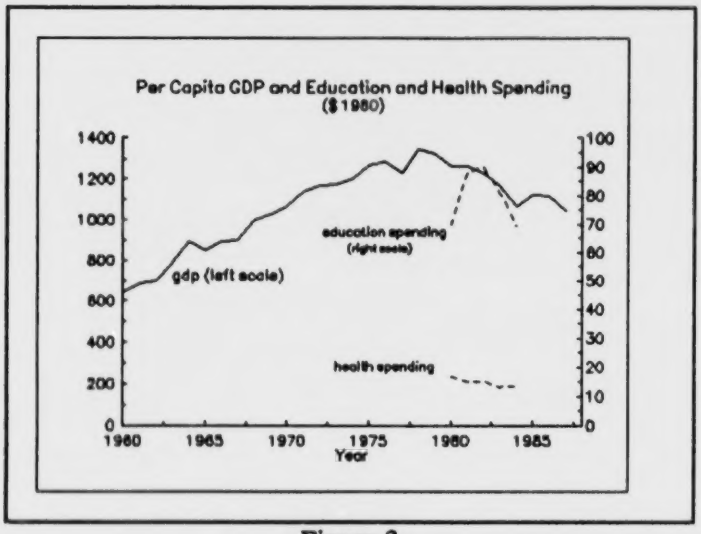

Figure 3
Source: African Economic and Financial Data

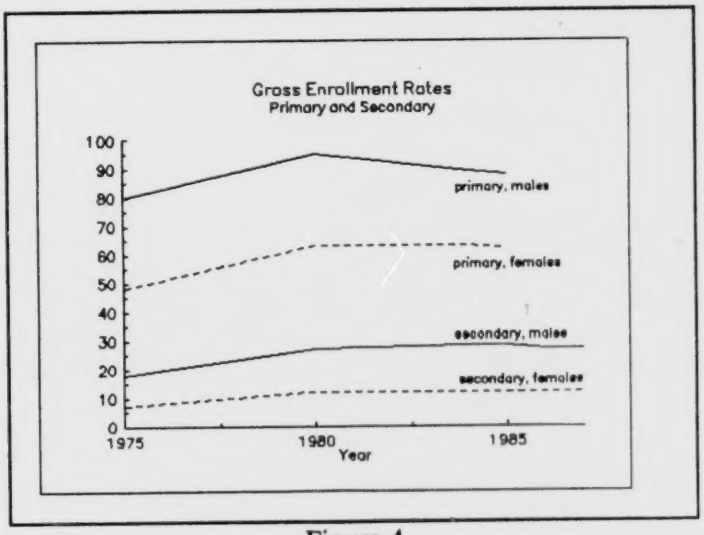

Figure 4
Source: *UNESCO Statistical Yearbook, 1991.*

All this suggests that at present, Côte d'Ivoire's education system is characterized by (i) an imbalance between capital and recurrent expenditures, the former being too low relative to the latter; (ii) a level of recurrent expenditures (these being devoted almost entirely to personnel) that may be too high relative to other demands on government budgets; and (iii) shortcomings and inefficiencies in performance that may be traced, in part, to infrastructural constraints and a rationing of student places (World Bank, 1990:6). Clearly Côte d'Ivoire has not succeeded in educating its population to a level consistent with the resources expended.

In such an environment, one educational policy option has attracted increasingly serious consideration: the possibility of shifting some of the recurrent costs of schooling to the private sector (Russell and Stanley, 1988). That is, Ivoirian households may be asked to assume a greater share of the full costs of education, particularly at the secondary and higher levels. The higher fees collected (or lower subsidies expended) could be employed in turn to ease the infrastructural and related constraints now afflicting the educational system.[2]

To evaluate such a policy, information is required on the price elasticity of the demand for schooling, that is, on the extent to which households respond to fee increases by decreasing the enrollment of their children. A full evaluation also requires that the spill-over effects on fertility be considered. Kelley and Nobbe (1990) and others have

2. See Gertler and Glewwe (1989) for an insightful analysis of this issue in the case of rural Peru.

argued that in Kenya, increases in the exogenous costs of schooling have given impetus to fertility decline. Is this a possibility in Côte d'Ivoire as well?

The discussion that follows is organized in six sections. In Section II we consider the concept of quantity-quality tradeoff in African settings. Section III describes the situation of the Côte d'Ivoire, and discusses the LSMS data. The methodological issues involved in the analysis of these data are addressed in Section IV. In Section V, we examine the major determinants of fertility and child schooling, with special attention to mother's education, household permanent income, and urban and rural residence. Section VI takes up the question of price elasticities of demand for child schooling. We estimate these elasticities and test for spill-over effects on fertility. Our conclusions are presented in Section VII.

The Quantity-Quality Tradeoff: An Overview

Economic development brings about change not only in family sizes, but also in the allocation of resources among family members. Developing societies generally undergo a transition from relatively large family sizes with low levels of human capital investment per child, to smaller families characterized by higher levels of investment per child (Birdsall, 1988). This quantity-quality tradeoff has its roots in the perceived benefits and costs of child schooling. In the course of modernization, labor markets come to display significant differentials in earnings according to schooling level. Parents then begin to view schooling as an avenue to a better life for their children, and as a human capital investment which may over the long term pay dividends to the parents themselves. Yet education is costly both in terms of direct costs and opportunity costs of foregone child labor; it is generally too costly for parents to give each child schooling and continue to bear the number of children appropriate to traditional circumstances. Some element of household expenditures must give way, and typically fertility falls as household investments in education per child increase.

Perspectives on Causation

As noted above, the tradeoff between fertility and child schooling should be understood to represent a systematic association between two *endogenous* variables. High fertility does not in itself cause low school enrollment, nor does higher school enrollment cause low fertility. Rather, each of these variables taken individually reflects the full set of opportunities and constraints facing households. We term this a "reduced-form" perspective on fertility and schooling.[3]

To understand the quantity-quality tradeoff from this point of view, we should ask what exogenous determinants of behavior, or what combinations of such determinants, have the effect of reducing fertility at the same time as they increase schooling per child. We should recognize that other outcomes are possible; indeed, nothing in the underlying economic theory requires the relationship between fertility and

---

3. Fertility can exert a causal influence on child schooling in the short run, however, especially under conditions of rapid and unanticipated change in economic circumstances such as those characteristic of the past decade in West Africa. In such settings, the number of children borne by the household may not correspond to the number that would have been chosen given knowledge of current economic circumstances. Those children who are already born, perhaps having been conceived under a previous economic regime, now place unanticipated constraints on current household choices, including choices regarding investments in their schooling. We might term this a "conditional" or "short term" perspective on the relationship between fertility and schooling.

This paper will adhere to the reduced-form perspective. We do so not out of a belief that the conditional perspective is somehow inferior on theoretical grounds. The concept of conditional demands is well-accepted in economics and some situations are clearly best analyzed with these conditional tools. Rather, the decisive issue is statistical in nature. Conditional analyses consider child schooling as being conditional on fertility decisions, and fertility itself is endogenous in a longer-run sense. Hence, the conditional formulation is vulnerable to unmeasured household traits that affect both schooling and fertility choices, thereby obscuring the estimated effects of fertility itself on schooling.

child schooling to be negatively-sloped. In some settings, for instance, higher household permanent income may be associated with higher fertility *and* higher schooling. If such sign patterns dominate, the fertility-schooling locus is positively-sloped.

In what follows we discuss the exogenous causal mechanisms in more detail, giving emphasis to the set of covariates, including levels of income, female education, urban residence and child mortality rates, that will figure prominently in our empirical analyses. We should emphasize here, however, one key mechanism that underlies the quantity-quality tradeoff: liquidity constraints affecting the ability of households to transfer resources across life-cycle periods. These constraints come into play in the following manner. Consider an exogenous increase in the economic benefits associated with schooling, such as a greater wage premium for educated labor. If parents can make claims on some portion of the earnings of their children, as they certainly can in Sub-Saharan Africa, then this improvement in the earnings potential of educated children is equivalent to an increase in household full wealth. Indeed, it would seem to enhance the anticipated return to childbearing in general. Why then should fertility fall? The key point is that African parents cannot borrow on the basis of their full wealth or anticipated returns to child schooling, so as to finance the required educational investments in children. Their investments must instead be financed out of current income, or drawn from capital that has been amassed at the point when the child is of school age. Such binding period-specific budget constraints imply that current fertility, consumption or both may need to be reduced if parents are to take advantage of the future returns to schooling. We shall return to this point below, in connection with features of social organization that affect the budget constraints facing West African and Ivoirian parents.

The Role of Exogenous Covariates

Consider the reduced-form relationship between fertility and schooling, on the one hand, and their exogenous determinants, on the other. We can represent the relationships in a general fashion as follows:

$$\begin{array}{rcl} F & = & f(I , E , U , M) \\ & & (?)\,(-)\,(-)\,(+) \end{array}$$

$$\begin{array}{rcl} S & = & s(I , E , U , M) \\ & & (+)\,(+)\,(+)\,(?) \end{array}$$

where F represents fertility, S is a measure of schooling per child. The set of exogenous covariates (I,E,U,M) includes: permanent income, I; women's education, E; urban residence, U; and child mortality rates, M. The expected signs of the relationships are indicated below the variables in each equation.

Permanent income (I) has an ambiguous effect on fertility in economic models of the quantity-quality tradeoff. In the Becker and Lewis (1973) formulation, fertility (F) and schooling per child (S) are regarded as being substitutes, in the economic sense of the term, and if S were to be held constant then the demand for children (F) would tend to increase with income. However, schooling is itself a normal good, the demand for which increases with the level of income, and schooling expenditures are an important

component of overall childrearing expenditures. Thus, as income and demand for schooling increase, so does the "shadow price" of children. One might therefore expect fertility to increase with respect to income up to some threshold income level, but to decrease thereafter as the shadow price effect comes to dominate the relation. That is, F might well behave as a normal good in one portion of the income span, and as an inferior good at higher levels of income.

As long as income remains in the range in which both F and S are normal goods, changes in I produce changes in the same direction in both F and S. That is, F and S are positively associated. If one were to plot F and S in a quantity-quality diagram analogous to Figures 1 and 2, the plot would show no evidence of a quantity-quality tradeoff. When income is in the range in which F is inferior and S is normal, however, F and S are negatively associated and a quantity-quality tradeoff emerges in response to income growth.

This discussion illustrates one key point. In seeking to understand the root causes of a quantity-quality tradeoff, we search for exogenous covariates having effects on F and S that are of *different* sign.

Women's education (E) could produce such a tradeoff, although the causal mechanisms at work remain a matter of dispute. One expects that the greater is a woman's educational attainment, the lower is her fertility and the greater are her investments in child schooling. What is at issue is the interpretation to be placed on such a relationship.

Economists have often drawn attention to the link between education and labor market earnings. The argument runs as follows. The higher is a woman's educational attainment, the greater is her potential wage. If time spent in work and time in child care are mutually exclusive, then the wage rate indexes one of the principal opportunity costs of childrearing. If these opportunity costs dominate in fertility decisions (higher wages also imply higher full wealth) it follows that the higher the price of time, the lower should be fertility.

It is not at all clear that this chain of reasoning can be applied to African economies. For most Ivoirian and indeed most African women, work need not conflict directly with child care. Where a conflict exists, it can be readily resolved through the employment of low-cost substitutes for the mother's time in child care, such as care provided by relatives. The relevance of the opportunity cost argument in African settings is therefore doubtful, particularly in rural settings and in occupations in which work time and child care time are mutually compatible.

Caldwell (1982) envisions a larger role for education than what is considered in the simple economic model. In his view, education serves as a vehicle for the adoption of Western ideas regarding the family. It encourages a more child-centered view of one's parental responsibilities. Education may alter the definition of what constitutes acceptable child care, giving greater emphasis to the time spent by the mother with her child, as compared to time supplied by mother-substitutes. Education may also affect the distribution of authority within the household, so that educated women gain a measure

of autonomy vis-à-vis their husbands, and couples gain vis-à-vis their elders. Thus, in the within-household bargaining over resources, educated women may be able to claim a greater share for their children.

The simple economic model suggests that women's education should exert a negative influence on fertility; it has little to say about an impact on child schooling investments. To the extent that education is associated with higher wages, the implied income effect may serve to increase schooling per child. Caldwell's view, by contrast, suggests that women's educational attainment is linked to changing standards in respect to child care and child investments, including schooling. There is a backwards link to fertility, in the sense that the shadow price of fertility is affected by changing standards regarding investments per child. Taken together, these two viewpoints support the sign pattern indicated above, whereby an increase in women's education E is predicted to reduce fertility and increase schooling per child.

Urban residence (U) is associated with a host of exogenous factors that, taken collectively, may result in lower fertility and higher schooling per child. A variety of childrearing costs may be higher in urban areas, such as food prices and the price of lodgings. In addition, the value of child labor may not be as high in urban settings as it is in rural.[4] There may be a clearer appreciation of the benefits of schooling in settings in which labor markets contain greater numbers of the educated. The costs of access to schooling, particularly in regard to secondary schooling, may be lower in urban areas, as would the costs of access to family planning services.

Child mortality rates (M) are expected to have both direct and indirect effects on fertility. The direct impact, sometimes termed a "physiological effect," occurs when a child dies while being breastfed. By terminating breastfeeding, such a death re-exposes the mother to the risk of conception. Or to put it the other way, when child survival rates improve, there are fewer such deaths and the contraceptive effect of breastfeeding is maintained for longer periods on average. Empirical estimates (Lloyd and Ivanov, 1988) suggest that in fertility and breastfeeding regimes similar to those of Sub-Saharan Africa, a reduction of one child death would be associated with a mean reduction in fertility of perhaps half a birth. The indirect influence of child mortality rates on fertility has to do with an "insurance effect," whereby if sufficient numbers of children are to survive in the face of high mortality risks, parents may have more births than they would require in circumstances of low mortality.

The effect of child mortality rates on schooling are less clear. It is plausible to suppose that greater certainty about child survival may translate into greater parental willingness to undertake many forms of human capital investments in children. But note that even in the high-mortality environments of Sub-Saharan Africa, where as many as

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4. A need for child labor to ensure a minimum level of agricultural production may imply that only large families will have the surplus labor available that can be educated. This mechanism can, but need not, result in a positive association between fertility and schooling *per child*. A positive association is more likely if small families cannot educate their children at all and must devote the full family labor force to agriculture.

one-quarter of children may fail to survive to their fifth birthday, the death of a school-age child remains a relatively uncommon event. Thus it is doubtful that a relationship between mortality rates and educational investments has to do with the survival prospects of school-age children themselves. One alternative possibility has to do with the mortality insurance effect mentioned above. If parents facing high child mortality risks tend to have higher fertility, so as to protect themselves against the possibility of future child deaths, they may find themselves with more school-age surviving children than strictly required as well. These additional surviving children may put pressure on available household resources, causing schooling investments to be spread thin. Such a mechanism could cause higher mortality rates to be associated with higher fertility and lower schooling per child.

African Family Structure and the Tradeoff

The possibility of an indeterminate relationship between quantity and quality, or a positive relation, merits special consideration in African settings. There are three principal features of social and familial organization that may affect the strength and sign of the tradeoff: (i) the existence of sibling chains of support; (ii) child fostering; and (iii) the nature of within-household decisionmaking and the division of childrearing responsibilities.

Sibling chains of support involve a set of obligations on the part of adult offspring to their parents and their younger siblings. It is often said (Gomes, 1984) that the education of the eldest child is truncated, so that he or she can begin to work early and provide support for the schooling of younger siblings. There is an incentive on the part of parents to begin childbearing early, so that their eldest child will be in a position to lend support to the greatest number of younger siblings. Sibling chains of support can be regarded as a way by which high fertility early in the reproductive life cycle eases parental liquidity constraints later in their life cycle. This mechanism raises the possibility that high fertility may be associated with greater schooling per child, at least for the younger children in the family.

Child fostering provides a means by which childrearing costs can be spread among a network of relatives (Ainsworth, 1992). The institution of fostering is pervasive in Côte d'Ivoire and in West Africa more generally. It enables parents to escape some of the costs of schooling that might otherwise, given liquidity constraints, make it necessary that fertility be reduced if the children are to be properly educated. Thus, we would expect the institution of child fostering to weaken the association between fertility and schooling per child.

Complementary features of social organization include a lack of joint decision-making and resource pooling between husbands and wives, which may influence each spouse's perceptions of the full costs of childrearing; and the role of polygynous marriage in affecting bargaining within the household, fertility and investments in children. Taken in combination, these aspects of social and familial organization lead some observers (notably, Caldwell and Caldwell, 1987; van de Walle and Foster, 1990) to doubt the prospects for a quantity-quality demographic transition. It is often said (Fapohunda and Todaro, 1988) that women tend to face the marginal costs of childbearing, in that they

bear responsibility for household expenditures that vary directly with the number of children, whereas husbands take responsibility for fixed costs (rent and the like) that are little affected by the level of fertility. On the margin, therefore, the husband might view additional births as entailing fewer costs than what are perceived by the wife. In polygynous bargaining situations, in which the desires of one wife may be played against the desires of another, the husband's wishes regarding fertility may well prevail.[5]

Caldwell and Caldwell (1987) maintain that the absence of a quantity-quality tradeoff is implicit in the nature of West African household structure and decision-making. They assert that:

> The African family structure typically places reproductive decisionmaking in the hands of the husband and the economic burden mainly on the shoulders of the wife. Nothing could be more conducive to maintaining high fertility. [Caldwell and Caldwell, 1987:421]

Furthermore, in regard to schooling:

> So weak [is the link between a man's reproductive decisions and his expenses,] that there is little parallel to the situation in some other parts of the Third World where educated children will ultimately benefit parents but where there is such a financial crunch during the process of education that numbers must be restricted to ensure that any are sufficiently educated and adequately employed. [Caldwell and Caldwell, 1987:422]

The early empirical literature on the quantity-quality tradeoff in Africa suggests that the terms of the tradeoff are indeed very different from what prevails in Asia or Latin America. DeLancey (1990:120-121) reviews the evidence from a handful of studies based on data for the late 1960s to mid-1970s for Kenya (see Gomes, 1984), Botswana and Sierra Leone. This research finds little evidence of a negative relationship between child schooling and fertility in Africa. Where significant associations are uncovered, they tend to be positive rather than negative as is the case elsewhere.

It should be noted, however, that this early literature suffers from a number of flaws, most prominent among these being the treatment of fertility as an exogenous explanatory variable in equations concerning child schooling. (See Part III for further discussion of methodology.) In addition, for the reasons listed above one might expect the tradeoff between quantity and quality to be weak when (i) the economic benefits of

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5. This paper is not the place for a full discussion of the issues, but see the forthcoming National Research Council report of the Working Group on Factors Affecting Contraceptive Use in sub-Saharan Africa, Panel on Population Dynamics of sub-Saharan Africa, Committee on Population, for a comprehensive account.

schooling are not firmly established,[6] a matter that depends on the emergence of skill differentials in the labor market; and (ii) when the private exogenous costs of schooling are heavily subsidized, as was the case through the 1970s in a number of African countries with policies of free primary education. Thus the early studies need not provide a reliable guide as to the nature of the quantity-quality tradeoff in contemporary settings.

Educational Policies and the Tradeoff

A good deal of attention has been given to the implications for fertility of policy-induced changes in the costs of schooling in Africa (Kelley and Nobbe, 1990, for Kenya). In some accounts, these schooling costs are said to provide the fundamental basis for a quantity-quality demographic transition. Without doubt, the private financial burden of education shouldered by African parents is considerable (World Bank, 1988), and the 1980s have witnessed increases in the real prices of schooling (tuition, fees, capital levies, etc.) in a number of countries. Such policy-driven increases in prices could conceivably assist in a quantity-quality transition.

The origins of the transition in Africa are likely to be found not simply in the changes in the price of schooling, but rather in a changing configuration of benefits and costs. The private benefits accruing to an extra year of schooling consist in the extra earnings that year is expected to generate over a working lifetime, suitably discounted and adjusted for unemployment and earnings variability (World Bank, 1988). If parents perceive there to be little improvement in their children's earnings potential with the level of schooling, they may be quite sensitive on the margin to changes in exogenous prices. Faced with an increase in tuition or fees, they may simply respond by reducing human capital investments, as is indicated in movements from points A to C in Figure 1. If the earnings gradient is steep, on the other hand, parents may choose to respond to price changes in part by making sacrifices in other dimensions of behavior, including that of fertility, as shown in the A to D response. But one would not expect to observe a quantity-quality transition (A to B) induced by increases in school costs unless the benefits to schooling themselves improve.

To put the point in a different way, both quantity and child quality should fall when school prices are increased (A to D), provided that quantity and child quality are complements. This is the argument implicit in the liquidity constraint perspective.[7] We

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6. As DeLancey (1990) notes, in the case of Botswana ready access to the South African mines gives even uneducated children the potential for relatively high earnings. Therefore parents may not view the marginal contribution to earnings produced by schooling investments as being justified given the costs of such investments.

7. Note that in the conventional Becker-Lewis formulation, child quantity and quality are assumed to be net substitutes rather than complements, so that an increase in the exogenous price of schooling would cause fertility to increase.

(continued...)

would certainly not expect the demand for child quality to increase as the price of child quality increases: this would amount to an assumption of upward-sloping demands.

In short, the perceived economic benefits of schooling are critical to the quantity-quality tradeoff. They serve as a kind of fulcrum, giving the costs of schooling effective leverage against fertility. The returns to schooling depend in turn on conditions in the labor market; thus, policies affecting the labor market may play an important role in the quantity-quality transition.

7.(...continued)

As Martha Ainsworth has pointed out, if the price of schooling is itself correlated with the quality of schooling, the situation is more complex. In this case parents face a range of schooling options, these being distinguished according to quality level, with those of higher quality presumably commanding higher prices. In place of a single exogenous price of schooling, we now must consider an exogenous schedule of prices according to the level of school quality. Consider an upwards shift in this schedule, such that each schooling option is now associated with a higher price. Then if quantity (fertility) and quality are complementary, fertility should fall in response to the upwards shift in the price schedule.

The Côte d'Ivoire Setting and Data

Population and Labor Policy

As noted in the introduction, in the first two decades of its history Côte d'Ivoire experienced comparatively rapid economic growth. Growth was fueled by an economic policy based on agricultural development, on the one hand, and promotion of industrial development through foreign investment, on the other. This twin development strategy required an abundant and qualified labor force, which Côte d'Ivoire did not yet possess at the time of Independence.

In order to cope with the perceived shortage of labor, post-Independence government policy was directed to two fronts: to the encouragement of rapid population growth through immigration and high fertility; and to the development of the educational system. Immigration was seen as a short-term solution to the problem of labor shortage, while fertility and educational development were viewed as longer-term solutions.[8]

The consequence is that Côte d'Ivoire has been late to recognize the threat to development posed by rapid population growth. In 1990 the natural rate of population growth in Côte d'Ivoire reached a level of 3.3 percent, one of the highest rates in Africa, and if immigration is counted the overall rate of growth may be as much as 4 percent. These rates of growth imply population doubling times of 21 years or less, a daunting prospect given the absence until very recently (see République de Côte d'Ivoire, 1991), of any national-level commitment to family planning service delivery.

There has been some evidence of fertility decline in Côte d'Ivoire, but the decline has been modest at best. The World Bank (1992) estimates that total fertility rates were 7.4 per woman in 1965 and 6.7 in 1990. Only some 3 percent of married women of reproductive age currently use some form of contraception.

The government is now reconsidering its position regarding fertility control. Indeed, there is a clear commitment to public sector family planning service delivery expressed in the "projet de declaration de politique de developpement des ressources humaines". Family planning service delivery already exists through the activities of the "Association Ivoirienne de Bien-etre Familial". But to date, these services have been concentrated in urban areas. The involvement of the government may help in the extension of services to the rural sector.

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8. Even during the colonial period, the French administration faced what it regarded as a problem of labor shortage. The colonial solution involved the use of forced labor, applied both inside the colony and in neighborhood colonies such as Burkina Faso (Upper Volta) and Mali (French Sudan). This led to an important immigration from these territories even after the suppression of forced labor in 1946, especially from Burkina. In the post-colonial era immigration policy took two forms: a general acceptance of immigrants under what might be termed an "open-door" policy, and a signing of agreements with France and Burkina Faso to provide Côte d'Ivoire with a portion of the skilled and unskilled labor it needed for implementation of its development program.

The Educational System

In respect to the other aim of post-colonial development strategy, that of developing an educational system adequate to the needs of its work force, Côte d'Ivoire has made remarkable progress. As noted, at Independence the country suffered from a general shortage of qualified labor, especially given its ambitious development program (Kouamé, 1987). The priority given to improving education is evident in the sequence of development plans and in the increasing part taken by education in the capital budget of the state (12 percent in 1960; 30 percent in 1980) and in recurrent expenditures.

At present the Côte d'Ivoire educational system has three levels: primary school, secondary school and superior school. The normal duration of primary school is six years, which corresponds to six different grades. The successful completion of primary grade six leads to the Certificat d'Etude Primaire Élémentaire (CEPE), after the passage of a national exam. The primary system is dominated by the public sector. There are a few private schools at the primary level, especially in the towns, which absorb those students who do not obtain one of the limited places available in the public system. In 1986-87, approximately 11 percent of primary students were enrolled in private schools (République de Côte d'Ivoire, 1988).

A student's transition to public secondary school requires the successful passage of an exam called "concours d'entrée en sixième," on which the successful candidate must obtain (at least) a threshold score fixed according to the number of places available at the first form of secondary school. Children who do not succeed on this exam can have access to secondary school only if their parents pay for private secondary schooling. The secondary school system is somewhat complex. It has two "cycles," two types of training (general training, and technical and vocational training) and in both there are public and private schools. In the general training system, the duration of the first cycle is 4 years. The successful completion of this cycle leads to the Brevet d'Étude du Premier Cycle (BEPC). Access to the public second cycle, whose duration is three years, is based on a student's academic results; the decision is made by a national committee. Those who are in private schools for the first cycle of secondary training must pass an exam to gain access to the public second cycle. Students whose academic results are not sufficient to be considered by the national committee must pay to have access to private schools at the second cycle level. Over the 1980s, the percentage of private school enrollment ranged from 30 to 40 percent for the first cycle of secondary school and 19 to 27 percent for the second cycle (République de Côte d'Ivoire, 1988).

Second-cycle studies lead to the baccalauréat, which is an exam administered at the end of secondary school. Until recently, success on this exam automatically led one to the university. In addition, students who want to attend superior-level technical and vocational schools (the Grandes Écoles) are required to pass another exam.

The LSMS Data

The empirical basis for this research is provided by the three waves of the Côte d'Ivoire LSMS fielded in 1985-87. Ainsworth and Munoz (1986) describe the survey design and data collection procedures. In each surveyed household containing a woman

of age 15 or older, one such woman was selected at random to give information as to the dates of birth of her children (if any), their sexes and survival status, and their current residence in the household. In addition, another module of the household questionnaire sought information from an informed household member (not necessarily the mother) on children's school enrollment, completed grades, and educational expenditures for each enrolled resident child.

Our approach was to proceed through the woman's birth history, selecting all children aged 5 to 30 who were reported as being alive at the time of the survey; for each such child we then attempted to determine the grades of schooling that he or she had completed, and current enrollment status.

In so doing, we have restricted ourselves to the children of the woman in question. We do not examine the educational status of any other children in the household, who could represent the children of co-wives or fostered-in children. Thus, *the unit of analysis in our research is the individual woman and her own natural children, if she has any children.* This choice of analysis unit has implications for the treatment of marital status and the characteristics of the husband, as will be discussed below.

Special procedures were employed by LSMS interviewers to glean information on the schooling of children who were alive but no longer resident in the household. These procedures were made necessary by the considerable circulation of children among households in Côte d'Ivoire. As previously noted and discussed in detail by Ainsworth (1992), high proportions of Ivoirian children are fostered-out from their natal households, away from both the natural mother and father; and owing to marital dissolution, considerable proportions of non-fostered children will also reside away from their mothers. In our sample, nearly 16 percent of children aged 5-7 reside away from their natural mothers, and these proportions increase sharply with age.

The schooling data collected on children who reside elsewhere are not as detailed as those collected for resident children. Current enrollment is known for children residing away, as is the grade level completed. However, future enrollment intentions are not known, nor are schooling expenditures available in a form comparable to that for resident children.

Our analysis plan exploits the data on both resident and non-resident children. Thus wherever possible, we will consider educational measures that are available for both types of children.[9] Where expenditures on schooling are concerned, we have no option

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9. In some 18 percent of cases, children listed in the woman's fertility history as being alive and of an age for which schooling information should have been available, could not be located in the portion of the household roster in which schooling data are reported. These non-matching cases are omitted from the schooling equations (see below).

but to make a statistical adjustment for selectivity bias (see Section V below). We believe this is preferable to analyzing data for resident children alone, as the resident subsample may be biased in any number of respects.

The LSMS also collected community-level data on market prices for both urban and rural sample clusters, along with community-level data on educational infrastructure and perceived educational problems for the rural (but not the urban) clusters.

Additional data on primary schools are available at the inspectorate level, a unit of aggregation that may include more than one sample cluster. We have also included some information available in published tables of the 1988 Ivoirian census, concerning child survival and male labor force composition.

Methodology

The methodology proceeds from two principles: (i) the reduced-form perspective, and (ii) the focus on a woman and her own children as the unit of analysis. With these in mind, we will estimate reduced-form equations for fertility and child schooling of the general form

$$\begin{aligned} F &= X\beta_F^1 + Z\beta_F^2 + \varepsilon_F \\ S_1 &= X\beta_S^1 + Z\beta_S^2 + W_1\beta_S^3 + \varepsilon_{S_1} \\ S_2 &= X\beta_S^1 + Z\beta_S^2 + W_2\beta_S^3 + \varepsilon_{S_2} \\ . &= . \\ . &= . \end{aligned} \qquad (2)$$

where F is a measure of the woman's fertility; S_i is an indicator of child schooling levels for her child i; X is a set of exogenous family-level covariates; Z includes measures of community-level characteristics and policy variables; and W_i represent covariates specific to child i, such as age and sex. For a woman without a child we would consider only the first equation in the set; for a woman with N children of ages 5 to 30, there would be N schooling equations to consider.[10,11]

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10. Pitt and Rosenzweig (1991) give a lucid presentation of the self-selection problem that arises in connection with this set of equations. Women (whether directly or indirectly) make choices regarding fertility that determine how many of the S_i equations are actually observed at the time of survey. In general, one suspects the ϵ_F and the various ϵ_S disturbance terms of being correlated. If the S_i equations are estimated without a correction for the implied self-selection, the education coefficients could be seriously biased, at least in principle.

We intend to explore the self-selection estimators in future work. We should note, however, that the single analysis of child schooling and fertility known to us that uses such techniques, that of Pitt and Rosenzweig for Malaysia, comes to a curious conclusion. Pitt and Rosenweig find ample evidence of cross-equation correlation, that is, of a high (negative) correlation between the ϵ_F and ϵ_S error terms, as might be expected. In short, there is a great deal of selectivity. But there is rather little indication of selectivity *bias*: their uncorrected coefficients differ surprisingly little from the corrected coefficients.

11. We should note, in passing, that early work on the quantity-quality tradeoff focused on a pair of equations such as

$$\begin{aligned} F &= \alpha_0 X + \alpha_1 Z + \alpha_2 S + \varepsilon_F \\ S &= \beta_0 X + \beta_1 Z + \beta_2 F + \varepsilon_S \end{aligned}$$

Here the coefficients α_2 and β_2 are meant to represent the shadow prices of fertility and schooling, and the equations represent the first-order conditions of utility maximization. The equations we present in the text, by contrast, represent demand functions. The major difficulty in estimating first-order conditions is to find instruments for S and F on the right-hand side above. In principle, all of the exogenous variables describing household preferences and the household budget constraint will affect both F and S, so that exclusion restrictions cannot be rigorously justified.

(continued...)

In the exogenous X covariates, we include only the characteristics of the woman herself. We do not ask whether the woman is married, or if she is married, whether her husband is present or whether there are co-wives in the household. This attitude to the data is implicit in the reduced-form perspective, in that marriage, marital dissolution, polygyny and spousal co-residence are all regarded as being endogenous or potentially endogenous in nature.[12]

As for measurement of the dependent variables, we will consider two representations of fertility (F). The first is *cumulative fertility*, or the number of children born to the woman in question as of the survey date. We will also consider whether the woman has had *any births in the 5 years* preceding the survey. The advantage of the first variable is that it comes closest to the lifetime quantity measure envisioned in the theory of the quantity-quality tradeoff. The advantage to the second measure is that it refers to actions taken within a specific historical period characterized by specific policies and economic conditions, rather than to behavior carried out under a long sequence of economic and policy regimes.

The specification of child schooling (S_i) follows in parallel, although we make one addition. *Cumulative schooling* will represent the number of grades completed by the child as of the survey date, for children in the age range 5-30. *Current enrollment* represents schooling decisions in the year of the survey. We also develop a third measure of schooling that attempts to determine the number of years of schooling that a child may eventually complete. This measure draws together the data on grades completed as of the survey date and current enrollment at survey. The estimator is described in detail in Appendix 1; we shall refer to it as the ordered-probit estimator with an allowance for right-censoring, or as the projected schooling model.

Thus there are a number of issues in the estimation that concern discrete-valued and censored variables. The number of children ever born is obviously an integer variable; it is right-censored for women who are surveyed while still in their reproductive years. These difficulties are amplified in consideration of children born in the period of five years prior to the survey date. Completed years of schooling is also integer-valued and right-censored, as noted above.

11.(...continued)
This is another aspect of the "conditional" analysis problem noted above.

12. In addition, variables describing birth order and child spacing, which are of substantive interest in the quantity-quality tradeoff, cannot be explored via our reduced-form approach. The reason is that these variables are endogenous, and to condition on them implicitly conditions on the level and age pattern of fertility. For instance, if a child is of birth order three, this implies that the mother has had at least three children. We cannot easily compare such a child to one who is first-born, since for the latter the implied condition is that the mother has had at least one birth. The spacing between births, which may affect a household's liquidity constraints in regard to the financing of educational investments, obviously involves fertility.

In the fertility dimension, preliminary work with ordered-probit models (results not reported here) showed that ordinary regression models (OLS) behaved satisfactorily for cumulative fertility, in the sense that covariate effects were of the same sign and significance in the two approaches. In such cumulative fertility models, the age of the woman functions as a control for right-censoring. We chose to model recent fertility in terms of an ordinary probit equation, which simply records whether any birth occurred in the five years preceding the survey. This approach sacrifices information on the number of such births, but in terms of the estimated covariate effects, there was no apparent loss of substance relative to ordered-probit models. In regard to cumulative schooling, an ordinary regression model (OLS) also proved adequate to summarize covariate effects, with the age of the child used to control for right-censoring. Simple probit models were judged adequate to describe current enrollment. As noted above, the ordered-probit model with allowance for right-censoring addresses both the integer and the right-censoring aspect of the schooling data.

Results

In this section, we are concerned with the influence of a selected set of covariates on fertility and child schooling. The covariates in question are the woman's education, divided into categories of none, any primary, and any post-primary; her residence, classified as being in the Savannah region, the rural east or rural west forest regions, any urban area other than Abidjan, and Abidjan itself; and an indicator of permanent income measured by consumption expenditures per adult in the household. Consumption per adult is adjusted according to the regional and year-specific price deflators presented in McKay (1991) and is expressed in log form.

We will begin with a pooled sample that includes both urban and rural residents. Then we separately consider the rural and urban sub-samples. We close this section by examining the additional contributions made by nonlinearities in income and by a census-based measure of child survival. The results are summarized in three graphs that may shed light on the strength and direction of the quantity-quality tradeoff in Côte d'Ivoire.

Description of the Sample

Tables 1 and 2 present descriptive statistics on the dependent variables and key covariates in the analysis. The mean level of cumulative fertility is 3.86 births; some 53.85 percent of women had at least one birth in the previous 5 years. Among children, the mean value for years of school completed is only 2.78 years, but 37 percent of children in the sample are currently enrolled, that is, right-censored in respect to eventual educational attainment.

One can get a sense of the key differentials in these data by examination of Figures 5 to 18. In Figures 5 to 8 we show differences in fertility and child schooling according to the education of the woman. (Age, whether of the woman or the child in question, is included here as a control variable.) Fertility is high for all education groups; nevertheless, important differentials are evident according to schooling in both the cumulative and recent fertility graphs. Note that there is little difference in fertility between women without schooling and those with primary schooling until age 25, but at that point the fertility profiles diverge. Child schooling is also strongly associated with the schooling of the mother. In comparing cumulative schooling of children whose mothers have secondary training, to those whose mothers have no schooling, a gap of nearly 6 years emerges among children in their twenties.

These differentials are important, to be sure, but to put them in context, it should be recalled that secondary schooling has been far from common among women in Côte d'Ivoire. Table 1 shows the distribution of schooling for the full pooled sample, in which only 12 percent of women have progressed beyond the primary level. Among rural women (not shown in the table) only 1.8 percent have any secondary schooling; indeed, just 10.3 percent have any primary. Nearly one-quarter of urban women have some secondary training, however, and 22 percent have completed primary education.

Table 1. Descriptive Statistics on the Sample of Women

	Entire sample n = 4310	*Rural n = 2381*	*Urban n = 1929*
DEPENDENT VARIABLES			
Number of births	3.86	4.51	3.07
Any births, last 5 years	.539	.536	.541
INDEPENDENT VARIABLES			
Individual-Level Data			
Woman's Age	.161	.133	.196
15-19	.152	.121	.191
20-24	.155	.130	.185
25-29	.145	.099	.134
30-34	.098	.103	.092
35-39	.083	.102	.060
40-44	.068	.088	.044
45-49	.168	.224	.097
50+			
Woman's education [1]			
None	.726	.879	.538
Any Primary	.154	.103	.216
Beyond Primary	.120	.018	.246
Consumption/adult [2] (Log in CFA)	12.98	12.74	13.29
Residence			
Abidjan	.209		.467
Other Urban	.239		.533
Rural East Forest	.219	.397	
Rural West Forest	.132	.239	
Savannah	.201	.363	
Ethnicity			
Northern Mande	.108	.093	.126
Akan	.326	.345	.329
Krou	.117	.120	.114
Southern Mande	.155	.214	.083
Voltaic	.111	.121	.099
Other	.182	.127	.249
Survey Year			
1985	.330		
1986	.342		
1987	.328		

(Table 1 continues on next page)

Table 1 (continued) 28

	Entire sample n = 4310	*Rural n = 2381*	*Urban n = 1929*
Commune or Sous-Prefecture Data			
Survival Rate [3]	.807	.777	.844
Male Labor Force [4]			
Agriculture	.555		
Construction	.036		
Commerce	.101		
Transportation	.051		
Marketing	.195		
Primary School Inspectorates [6]			
Number of Schools	61.4		
Number of Classrooms	324.9		
Number of Teachers	339.0		
Number of Students	13341.0		
Number of Girls Enrolled	5562.7		
Cluster-Level Data			
Market prices [5] (normalized per unit weight)	.82		
Beef	.42		
Fish	.29		
Imported Rice	.22		
Rice	.72		
Tomatoes	.64		
Palm Oil	.12		
Maize	.19		
Millet	.08		
Manioc	.09		
Bananas	.12		
Palm Nuts	.36		
Peanuts	57.47		
Eggs (per egg)	6818.21		
Cloth (per ?)	761.59		
Sandals (per pair)			

Table 1 (continued)

	Entire sample n = 4310	*Rural n = 2381*	*Urban n = 1929*
Male Daily Agricultural Wage [7]		915.1	
Primary School [7]			
Not present		.152%	
Distance in Kms. (0 if present)		0.56	
Year Built		66.9	
Secondary School [8]			
Not Present [6]			.142%
Distance in Kms. [7]		28.7	
Year Built [6,8,7]		71.5	70.2
Schooling Problems			
No money		64.1%	
High costs		31.0	
No teacher		20.5	
No school		21.4	
No class		26.9	
Building class or school		23.1	
Building teacher's residence		38.5	
No furniture		9.6	
No transportation		35.7	
No space, other		82.3	

Notes:

1. A breakdown of single year of primary schooling shows: grade 1,4%; 2,1.3; 3,1.7; 4,1.6; 5,24; and 6,7.9% As for secondary schooling: grade 7,1.9%; 8,2.3; 9,1.9; 10,3.2; 11,.7; 12,.6; and 13+,1.6%
2. Log of: total non-exceptional expenditures divided by number of adults in the household.
3. Data source: 1988 Census. Ratio of surviving children to children ever born.
4. Data source: 1988 Census. "Sector Unknown" not included.
5. Data source: LSMS price questionnaire.
6. Primary schooling Inspectorates Data and Secondary School Urban Data collected by Aka Kouamé.
7. Data source: LSMS community questionnaire.
8. No rural LSMS clusters contain a secondary school.

Table 2. Descriptive Statistics on the Sample of Children

	Entire sample n = 8175	*Rural n = 5067*	*Urban n = 3108*
DEPENDENT VARIABLES			
Cumulative years of schooling	2.78	2.39	3.43
Current enrollment	.370	.283	.512
INDEPENDENT VARIABLES			
Individual Level Data			
Child's Age	.199	.186	.221
5-7	.128	.119	.141
8-9	.116	.108	.128
10-11	.101	.095	.110
12-13	.093	.092	.093
14-15	.075	.081	.066
16-17	.065	.073	.051
18-19	.224	.245	.189
20-30			
Mother's Education [1]	.849	.944	.695
None	.094	.052	.163
Any Primary	.056	.004	.142
Beyond Primary			
Consumption/adult (Log) [1]	12.95	12.78	13.24
Residence	.170		.446
Abidjan	.211		.554
Other Urban	.282	.454	
Rural East Forest	.126	.204	
Rural West Forest	.212	.3416	
Savannah			
Ethnicity	.102	.089	.124
Northern Mande	.340	.358	.310
Akan	.120	.133	.099
Krou	.149	.194	.076
Southern Mande	.108	.112	.100
Voltaic	.181	.113	.291
Other			
Female	.487%		
Survival rate [2]	.802	.778	.841

Notes:

1. Log of: non-exceptional expenditures divided by number of adults in the household.
2. Data Source: 1988 Census. Ratio of surviving children to children ever born.

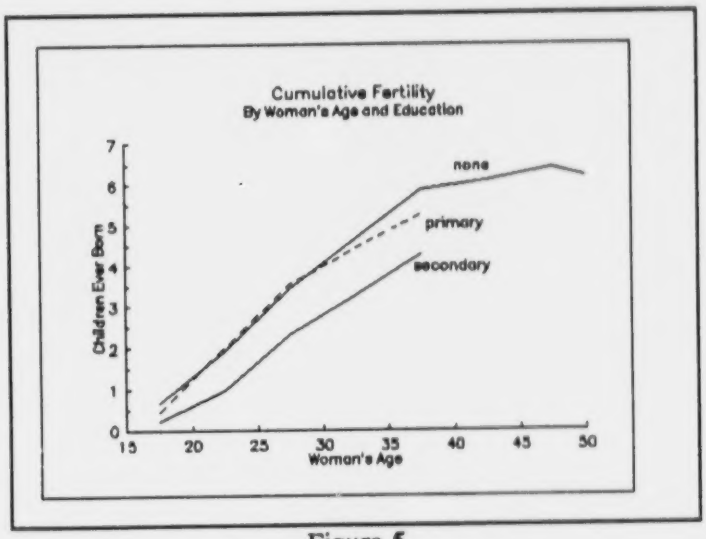

Figure 5

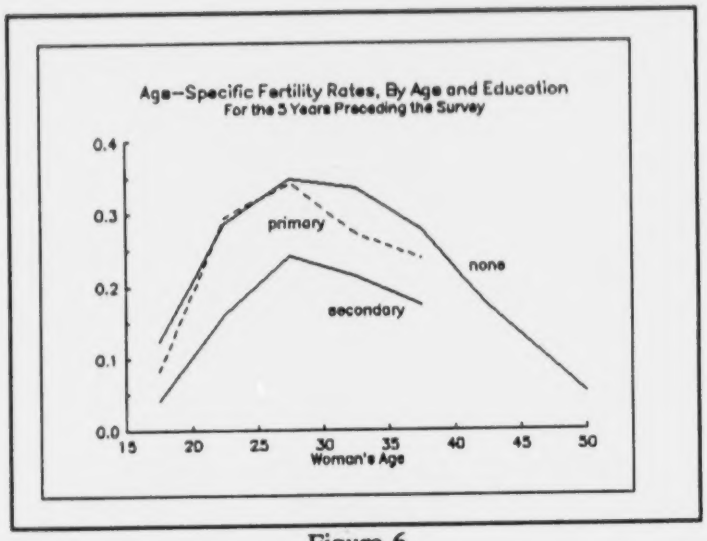

Figure 6

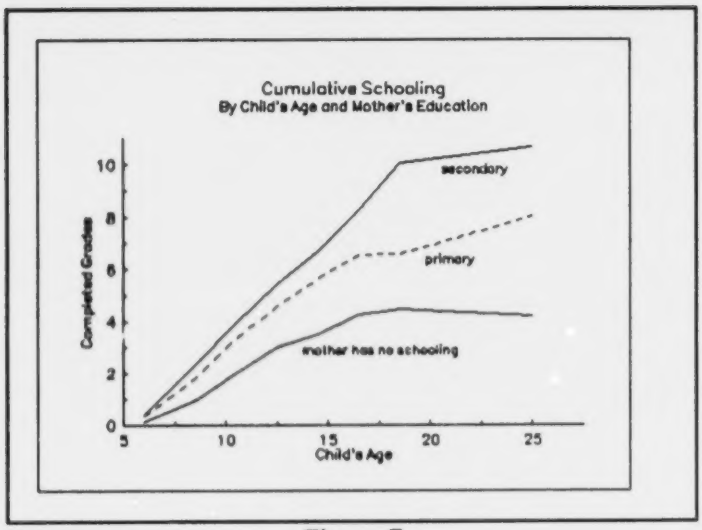

Figure 7

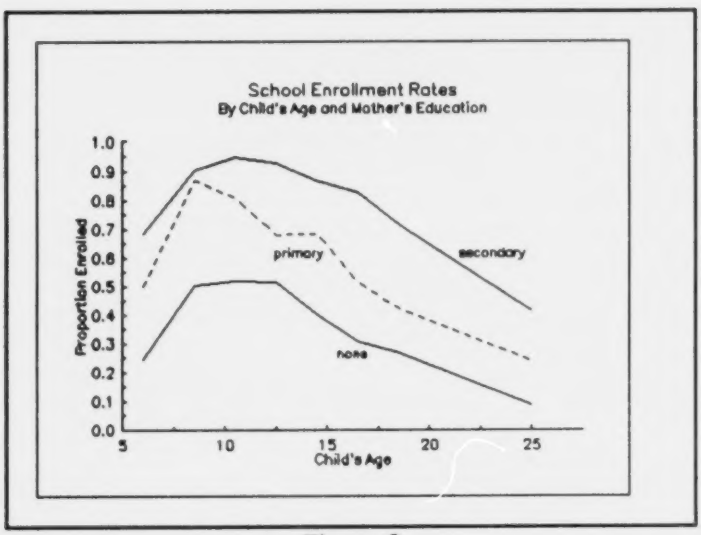

Figure 8

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Figures 9 to 12 explore these urban-rural differentials in more detail. We separate Abidjan from other urban areas in these comparisons. It seems that the important dividing line, however, is between rural areas and urban areas in general. As expected, urban fertility falls below fertility in rural areas, whereas urban schooling exceeds rural levels.

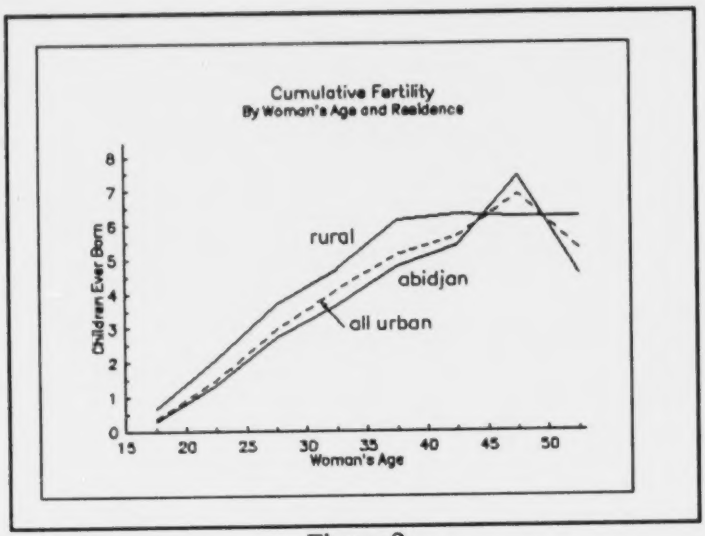

Figure 9

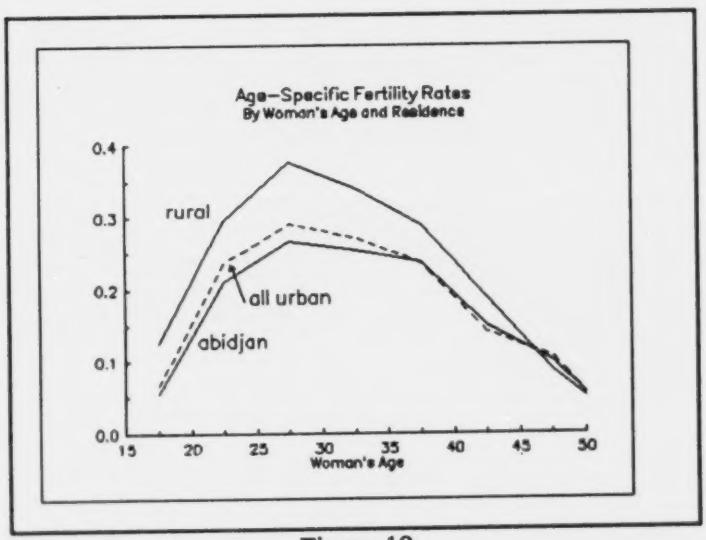

Figure 10

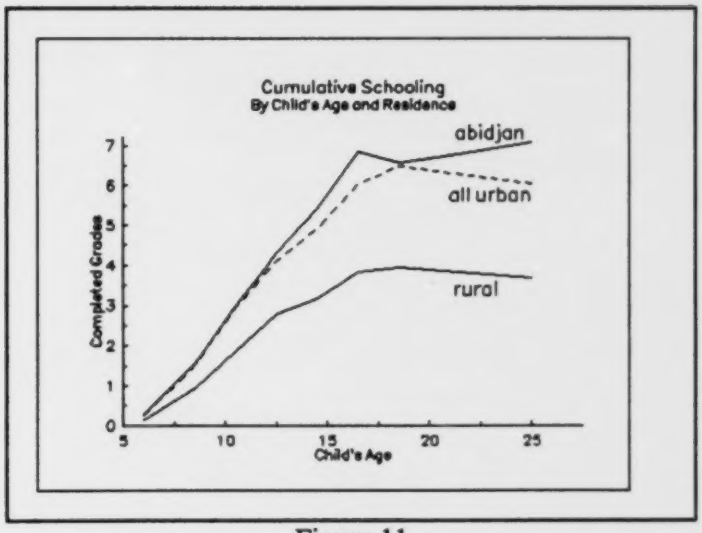

Figure 11

Figures 12 to 16 present breakdowns according to the percentile of household consumption per adult, which serves to mark the position of the household in the distribution of permanent income. In some contrast to the figures just presented, here the differentials in fertility are often weak or in unexpected directions. Of course permanent income is highly correlated with the woman's education and residence, and if these have an influence in opposite direction to that of income, the effect of income itself may be masked in the figures. In the schooling comparisons (Figures 15 and 16) a strong income effect is evident, although it is again confounded with education and residence, and in this case, perhaps exaggerated in size.

Finally, differences in child schooling according to the sex of the child are shown in Figures 17 and 18. The educational gap between male and female children is indeed large, a finding consistent with the aggregate enrollment ratio data presented in Figure 4.

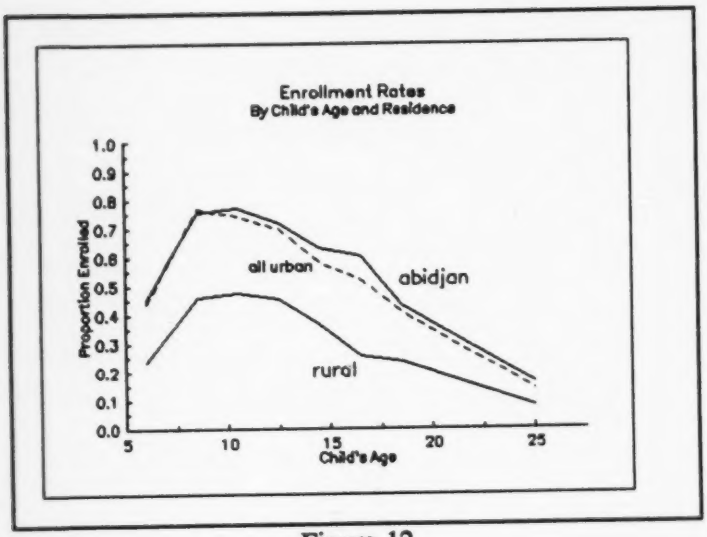

Figure 12

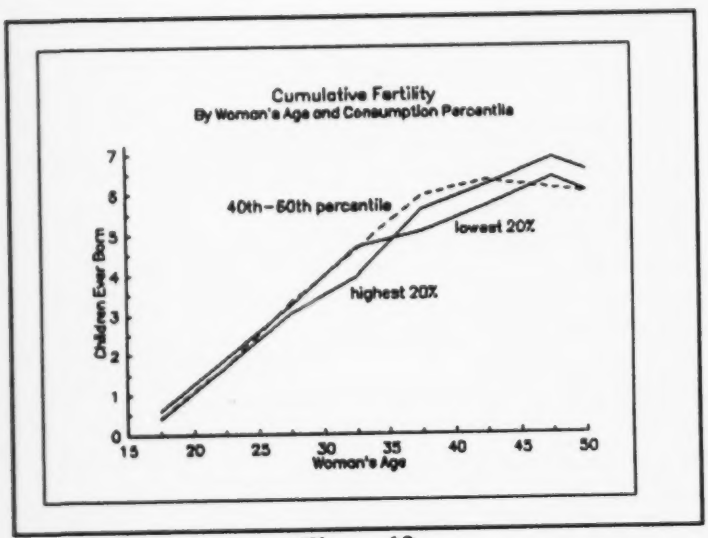

Figure 13

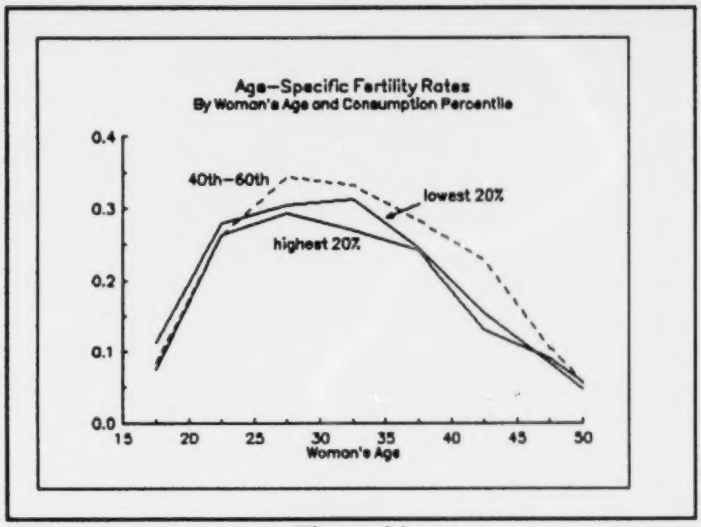

Figure 14

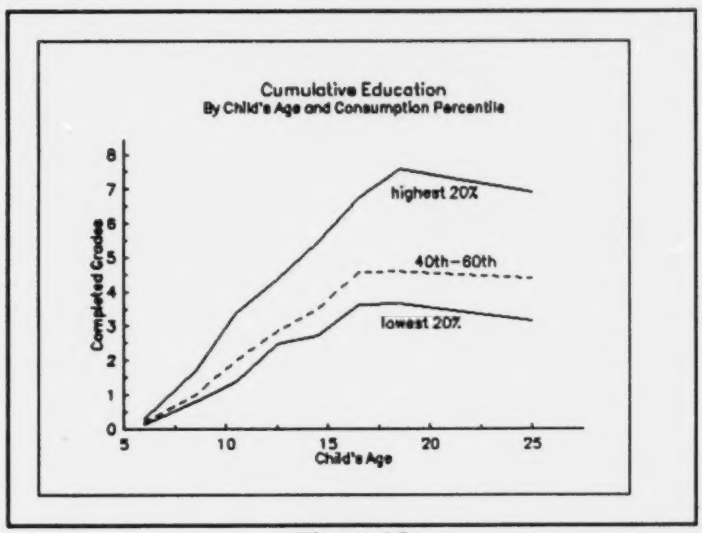

Figure 15

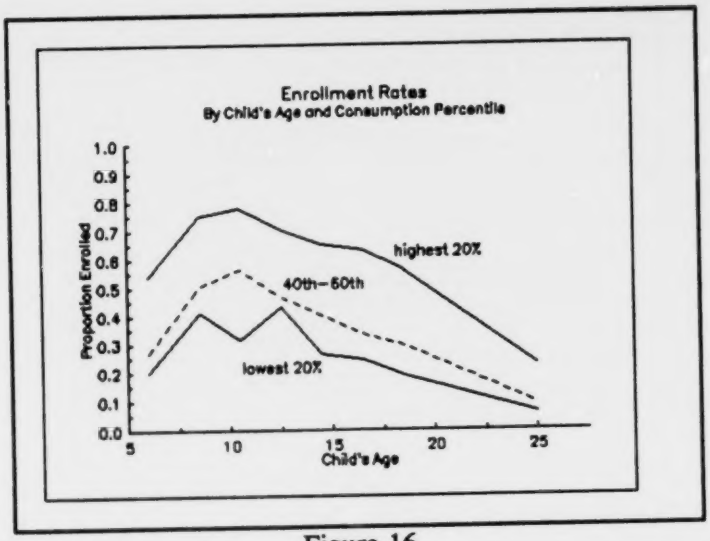

Figure 16

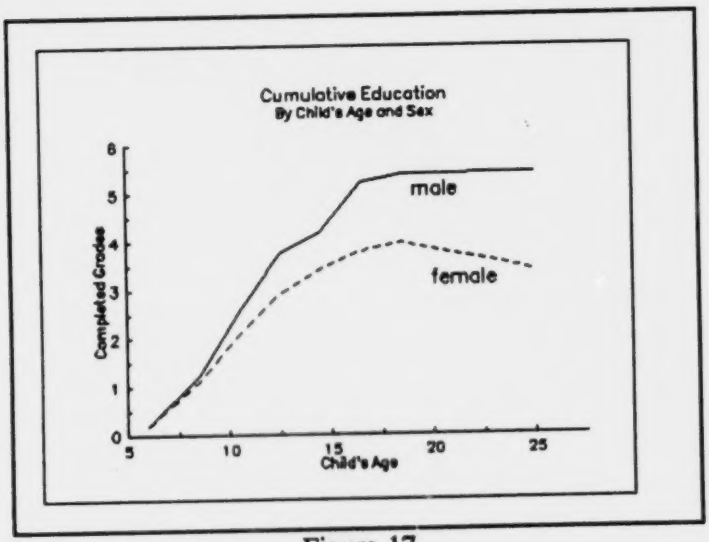

Figure 17

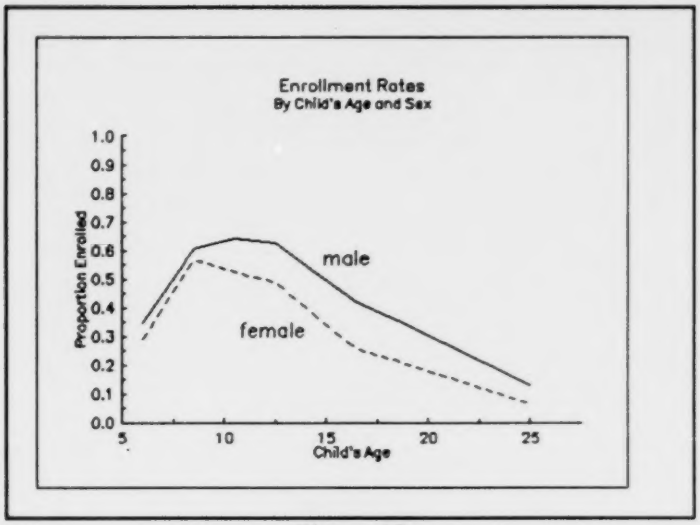

Figure 18

Multivariate Findings

Table 3 presents the results of a baseline analysis with urban and rural households pooled in the estimation. Ordinary least squares techniques are employed to estimate the cumulative fertility and cumulative schooling models in columns 1 and 3. Probit regression is employed for the recent fertility and current enrollment models in columns 2 and 4. Column 5 of the table presents the findings from the maximum-likelihood ordered-probit estimator. In all models, age is included as a control variable.

The estimated coefficients of several variables suggest a tradeoff between child quantity and quality. The coefficients on woman's schooling are negative in the fertility models (3 of 4 coefficients are significantly negative) and positive and highly significant in the schooling models. Residence in Abidjan and other urban areas is negatively related to fertility, as was also indicated in Figures 9 and 10, but positively related to schooling.

The coefficients on consumption per adult are perhaps surprising. Given controls for residence and woman's education, this measure of permanent income is now seen to be positively associated with fertility and positively associated with schooling as well. Thus, both fertility and schooling would seem to be normal goods. The elasticity of cumulative fertility with respect to consumption, although significant, is rather small at .060, which may be compared to Ainsworth's (1990) estimate of .08 to .09 for the households in 1985 only. (These elasticities are evaluated at the mean.) The elasticity of recent fertility is similar, being .069 at the mean. Cumulative schooling is more responsive than fertility to permanent income, with an elasticity of .195. The current enrollment elasticity is .339. All these estimates suggest that growth in permanent income would tend to increase both fertility and schooling per child, albeit with very

Table 3. Cumulative Fertility and Cumulative Schooling Models: Baseline Results, Full Sample (T-statistics in parentheses.)

	Women			Children		
	Cumulative Fertility (OLS)	*Any Births Last 5 Years[a] (Probit)*		*Cumulative Schooling (OLS)*	*Current Enrollment (Probit)*	*Projected Completed Schooling[b]*
Women's Education[c]						
Any Primary	-.080 (0.69)	-.136 (1.98)		.222 (2.02)	.327 (5.93)	.375 (4.90)
Beyond Primary	.-805 (5.91)	-.432 (5.45)		.330 (2.24)	.620 (7.64)	.687 (2.06)
Consumption per Adult (log)	.232 (4.23)	.114 (3.29)		.542 (11.66)	.291 (11.64)	.298 (10.30)
Residence[d]						
Abidjan	-.524 (4.01)	-.491 (5.84)		2.258 (20.30)	.895 (14.82)	1.288 (19.35)
Other Urban	-.168 (1.41)	-.304 (3.82)		1.900 (19.05)	.874 (15.76)	1.127 (21.36)
Rural East Forest	.572 (4.74)	.006 (0.07)		1.184 (12.39)	.516 (9.64)	.683 (10.41)
Rural West Forest	.063 (0.44)	-.125 (1.32)		1.084 (9.11)	.534 (8.28)	.558 (7.19)
Ethnicity[e]						
Akan	.021 (0.16)	-.067 (0.79)		.972 (8.61)	.399 (6.39)	.549 (2.27)
Krou	-.134 (0.83)	.032 (0.32)		1.796 (12.80)	.535 (7.32)	.964 (3.42)
S. Mande	-.169 (1.21)	-.209 (2.12)		.774 (6.10)	.432 (6.18)	.567 (2.16)
Voltaic	-.187 (1.12)	-.025 (0.25)		-.085 (0.65)	-.030 (0.40)	-.025 (0.98)
Other	-.010 (0.07)	.175 (1.93)		-.363 (2.97)	-.109 (1.64)	-.220 (0.86)
Woman's Age[f]			Child's Age[g]			-.008 (2.65)
20-24	1.246 (9.62)	1.076 (14.47)	8-9	.968 (9.04)	.809 (14.71)	
25-29	2.698 (20.68)	1.350 (17.07)	10-11	2.058 (18.64)	.793 (14.02)	
30-34	3.824 (26.89)	1.174 (14.00)	12-13	3.137 (27.11)	.744 (12.69)	
35-39	5.022 (33.20)	.799 (9.40)	14-15	3.724 (31.22)	.481 (7.99)	
40-44	5.363 (33.41)	.230 (2.64)	16-17	4.458 (34.70)	.176 (2.66)	
45-49	5.694 (33.17)	-.294 (3.08)	18-19	4.629 (33.90)	.026 (0.37)	
50+	5.226 (38.46)		20+	4.381 (46.31)	-.757 (13.42)	
Female				-.907 (15.17)	-.357 (11.02)	-.500 (0.86)
Constant	-2.216 (3.14)	-1.478 (3.31)		-8.307 (13.69)	-5.058 (15.31)	
R^2	.462			.386		
F or x^2 (p-value)	194.2 (.000)	767.7 (.000)		256.5 (.000)	2620.5 (.000)	2182.2[h] (.000)
Observations	4310	3588		8175	8175	8175

Notes:
a. Women aged 50 and over omitted.
b. Ordered probit model with allowance for right-censoring. Estimates of cut-point parameters α:4.149,4.202, 4.264,4.358,4.453,4.600,5.124,5.214,5.306,5.450,5.928,5.985,6.147(See Appendix for explanation.)
c. Omitted category: No schooling.
d. Omitted category: Savannah.
e. Omitted category: Northern Mande.
f. Omitted category: Age 15-19
g. Omitted category for cumulative and current enrollment models: Ages 5-7.
h. Test against null model with cut-point parameters α and child's age.

modest effects on fertility and a more substantial influence on schooling. We will return below to discuss the weight that should be attached to these interpretations.

The woman's schooling and residence effects can be read directly from their coefficients in the cumulative fertility and schooling models, as can the effect of sex in the cumulative schooling model. The probit estimates of columns 2 and 4, by contrast, require some translation. To consider the recent fertility probit first, the chance of a birth in the preceding five years is .666 for a woman without schooling, .623 for a woman with primary schooling, and only .527 for a woman with secondary. (All these are average predicted probabilities calculated allowing other covariates to vary as they do in the full sample. They give an idea as to the differentials associated with the covariate in question.) Women who reside in the savannah have a .701 probability of a recent birth; this probability is .702 for women in the rural east forest, .664 for women in the rural west forest, .608 for those in other urban areas, and .547 for women in Abidjan. The probability of a recent birth is .642 for the Northern Mande, but only .575 for Southern Mande; the other ethnic dummies are insignificant.

Similar calculations for school enrollment show that when the mother has no schooling, the average probability that her child will be enrolled is .350. This increases sharply to .448 when the mother has primary schooling, and to .538 when she has been educated to the secondary level. Enrollment is lowest in the savannah region, with an average probability of .217. This is less than half the enrollment probability in Abidjan, which is .471, or in the remaining urban areas (.464). Males on average have an enrollment probability of .420, as compared with only .318 for females.

The model of projected completed schooling (see Appendix 1) suggests that Ivoirian children will complete an average of 5.26 years (this can be compared to the sample average of 2.78 years, which is misleadingly low). The estimates imply that males will complete on average 6.11 years, and females 4.36 years. Children of mothers without schooling are themselves projected to complete only 4.89 years of school, as compared with 7.07 years if the mother has primary schooling and 8.46 years if she has any secondary training.[13]

The Endogeneity of Consumption

The estimates just discussed rest on an assumption that all covariates in the analysis are exogenous, that is, uncorrelated with the error terms in the associated fertility or schooling equation. This assumption is much in doubt where consumption per adult is concerned. Consider one scenario (and see Benefo and Schultz, 1992, for

13. In the ordered-probit model with allowance for censoring, the child's age should be interpreted differently than in the cumulative schooling model. In the cumulative schooling model, age is in large part a proxy for the span of time over which schooling can be accumulated. In the projected schooling model, this function of age has been taken up by the redefinition of the dependent variable (see Appendix 1), so that here, age should be interpreted as representing the effects of calendar time and other unmeasured but trended variables.

others). We see in Table 3 that consumption is positively related to fertility, and we have interpreted this as the effect of permanent income on fertility. But surely causation in the other direction is equally plausible. If children make a contribution to family income, and this contribution is reflected in consumption per adult, the positive association seen in Table 3 is at least in part the product of reverse causation.

To protect the estimates against this possibility, the standard practice is to predict consumption per adult using a set of exogenous instrumental variables, thereby purging (one hopes) the predicted value of consumption of any contamination from endogeneity. The instrumental variables technique is in principle beyond reproach. But in practice it is disturbingly vulnerable to the selection of the instruments and to multicollinearity. In many applications, it is not clear that the method brings one any closer to the truth.

That at least is our conclusion for Côte d'Ivoire; the basis for it can be found in Appendix 2. A series of instrumental variables estimations and formal exogeneity tests showed that: (i) the urban and rural samples should not be pooled in estimation; and (ii) once the data were partitioned into urban and rural sub-samples, no decisive evidence emerged in favor of the instrument-based results. That is, the tests neither sustained nor clearly rejected the assumption of exogeneity in consumption. There remains a possibility of bias in the uncorrected models, and our judgement is that if anything, the effects of permanent income on fertility may be upwardly biased in the uncorrected models, whereas the effects on schooling may be downwardly biased. As noted above, the (uncorrected) effects of income on fertility are modest in any case. With these cautions in mind, we now turn to the separate results for rural and urban areas.

Rural and Urban Sub-Samples

The results are presented for rural areas in Table 4 and urban areas in Table 5. With regard to rural fertility, we find that consumption remains positively associated with cumulative fertility, with an elasticity at the mean of .03. No significant effect appears in the recent fertility model, but the positive influence of consumption levels on schooling remains strongly significant in the rural sub-sample (elasticities of .249 for cumulative schooling and .375 for current enrollment). Woman's education loses significance altogether in terms of rural fertility (recall, however, that only 1.8 percent of rural women have any secondary schooling in rural areas). The effects of women's education on current enrollment, by contrast, remain positive. The negative schooling differentials for girls evident in the pooled sample reappear in the rural sub-sample.

Table 5 supplies the results for urban areas. Here consumption levels fail to reach significance in the cumulative fertility regression (while remaining significant in the recent fertility model, with an estimated elasticity of .114 at the mean) but show a strong influence on cumulative schooling and current enrollment, with elasticities of .168 and .297 respectively. Woman's education exerts a consistently negative influence on fertility within urban areas (although the primary school coefficient is not significant in the cumulative fertility model) and shows a consistently positive and significant influence on schooling. Within urban areas, as was the case within rural areas, parental schooling investments reveal a preference in favor of boys. The differences amount to half a year of schooling in the cumulative schooling model.

Table 4. Cumulative Fertility and Cumulative Schooling Models: Baseline Results, Rural Sample (T-statistics in parentheses)

	Women			Children		
	Cumulative Fertility (OLS)	Any Births Last 5 Years[a] (Probit)		Cumulative Schooling (OLS)	Current Enrollment (Probit)	Projected Completed Schooling[b] (Ordered Probit)
Women's Education[c]						
Any Primary	-.124 (0.65)	-.047 (0.43)		.148 (0.83)	.365 (4.19)	.543 (5.25)
Beyond Primary	-.454 (1.11)	.207 (0.92)		-.020 (0.03)	.484 (1.55)	.661 (1.36)
Consumption per Adult (log)	.368 (4.51)	.066 (1.27)		.593 (10.05)	.276 (8.54)	.307 (10.37)
Residence[d]						
Rural East Forest	.540 (3.78)	-.082 (0.91)		1.202 (11.40)	.494 (8.44)	.666 (12.89)
Rural West Forest	.139 (0.82)	-.129 (1.23)		.990 (7.71)	.498 (7.18)	.529 (8.31)
Ethnicity[e]						
Akan	-.013 (0.06)	-.067 (0.50)		1.081 (6.90)	.461 (4.98)	.625 (7.39)
Krou	-.358 (1.42)	-.049 (0.32)		2.150 (11.77)	.680 (6.59)	1.110 (11.66)
Southern Mande	-.424 (1.92)	-.364 (2.69)		.883 (5.44)	.453 (4.78)	.613 (7.09)
Voltaic	-.458 (1.92)	-.136 (0.95)		.036 (0.21)	-.108 (0.99)	-.006 (0.06)
Other	-.198 (0.80)	.137 (0.90)		-.474 (2.52)	-.299 (2.72)	-.333 (3.21)
Women's Age[f]			Child's Age[g]			-.012 (3.50)
20-24	1.371 (6.51)	.946 (8.32)	8-9	.764 (5.41)	.711 (9.80)	
25-29	2.907 (13.95)	1.360 (10.86)	10-11	1.571 (10.77)	.717 (9.57)	
30-34	3.956 (17.58)	.993 (8.03)	12-13	2.555 (16.76)	.692 (8.89)	
35-39	5.376 (23.69)	.724 (6.10)	14-15	2.938 (19.08)	.429 (5.40)	
40-44	5.580 (24.40)	.190 (1.66)	16-17	3.533 (21.92)	.052 (0.60)	
45-49	5.536 (23.19)	-.396 (3.23)	18-19	3.548 (21.11)	-.075 (0.82)	
50+	5.522 (28.11)		20+	3.351 (27.86)	-.778 (10.39)	
Female				-1.092 (14.33)	-.453 (10.71)	.578 (15.09)
Constant	-3.978 (3.78)	-.722 (1.09)		-8.362 (10.87)	-4.762 (11.18)	
R^2	.410			.329		
F or x^2 (p-value)	96.4 (.000)	364.7 (.000)		137.8 (.000)	1246.3 (.000)	1206.2[h] (.000)
Observations	2381	1847		5067	5067	5067

Notes:
a. Women aged 50 and over omitted.
b. Ordered probit model with allowance for right-censoring. Estimates of cut-point parameters α:4.226,4.280, 4.348,4.444,4.435,4.681,5.207,5.276,5.339,5.445,5.911,5.966,6.121(See Appendix for explanation.)
c. Omitted category: No schooling.
d. Omitted category: Savannah.
e. Omitted category: Northern Mande.
f. Omitted category: Age 15-19
g. Omitted category for cumulative and current enrollment models: Ages 5-7.
h. Test against null model with cut-point parameters α and child's age.

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Table 5. Cumulative Fertility and Cumulative Schooling Models: Baseline Results, Urban Sample (T-statistics in parentheses.)

	Women			Children		
	Cumulative Fertility (OLS)	*Any Births Last 5 Years (Probit)[a]*		*Cumulative Schooling (OLS)*	*Current Enrollment (Probit)*	*Projected Completed Schooling[b] (Ordered Probit)*
Women's Education[c]						
Any Primary	-.036	-.286		.445	.329	.317
	(0.26)	(3.12)		(3.30)	(4.50)	(3.88)
Beyond Primary	-.761	-.589		.665	.651	.721
	(5.49)	(6.36)		(4.29)	(7.24)	(6.52)
Consumption per Adult (log)	.083	.166		.574	.347	.321
	(1.18)	(3.45)		(7.91)	(8.50)	(7.73)
Residence[d]						
Abidjan	-.324	-.186		.406	.015	.160
	(3.39)	(2.73)		(4.29)	(0.29)	(3.03)
Ethnicity[e]						
Akan	.025	-.027		.852	.300	.438
	(0.16)	(0.24)		(5.45)	(3.46)	(5.17)
Krou	.072	.147		1.044	.246	.646
	(0.36)	(1.07)		(5.26)	(2.23)	(5.66)
S. Mande	.250	.063		.865	.421	.566
	(1.16)	(0.43)		(4.06)	(3.50)	(4.54)
Voltaic	.165	.237		-.342	.066	-.047
	(0.81)	(1.62)		(1.77)	(0.61)	(0.45)
Other	.132	.248		-.310	-.007	-.172
	(0.80)	(2.16)		(2.00)	(0.08)	(2.04)
Women's Age[f]			Child's Age[g]			.001
						(0.02)
20-24	1.167	1.245	8-9	1.237	.956	
	(7.61)	(12.32)		(7.95)	(11.09)	
25-29	2.568	1.443	10-11	2.705	.902	
	(16.37)	(13.58)		(16.89)	(10.28)	
30-34	3.775	1.392	12-13	3.931	.802	
	(21.85)	(12.00)		(23.32)	(8.87)	
35-39	4.680	.953	14-15	4.861	.531	
	(23.86)	(7.64)		(27.17)	(5.68)	
40-44	5.143	.319	16-17	5.944	.346	
	(22.30)	(2.24)		(29.23)	(3.29)	
45-49	6.379	-.034	18-19	6.598	.158	
	(24.62)	(0.21)		(29.23)	(1.35)	
50+	4.714		20+	6.166	-.746	
	(23.71)			(41.75)	(8.66)	
Female				-.615	-.223	-.364
				(6.72)	(4.41)	(7.11)
Constant	-.455	-2.604		-7.829	-5.041	
	(0.49)	(4.11)		(8.12)	(9.29)	
R^2	.490			.495		
F or x^2	114.9	416.4		177.8	1011.1	512.2[h]
(p-value)	(.000)	(.000)		(.000)	(.000)	(.000)
Observations	1929	1741		3108	3108	3108

Notes:
a. Women aged 50 and over omitted.
b. Ordered probit model with allowance for right-censoring. Estimates of cut-point parameters α: 3.454, 3.505,3.556,3.649,3.754,3.903,4.427,4.549,4.684,4.882,5.387,5.452,5.622(See Appendix for explanation.)
c. Omitted category: No schooling.
d. Omitted category: Other Urban.
e. Omitted category: Northern Mande.
f. Omitted category: Age 15-19
g. Omitted category for cumulative and current enrollment models: Ages 5-7.
h. Test against null model with cut-point parameters α and child's age.

Ethnicity appears to make only a modest difference to rural fertility levels, with the Southern Mandé and Voltaic peoples having slightly lower fertility than other groups. Ethnic differentials in regard to schooling, however, are striking. The Akan, the Krou and the Southern Mandé all make higher schooling investments in their children, all else being equal, than do the other ethnic groups. These ethnicity effects on schooling are evident in both rural and urban areas; the ethnic influence on fertility, however, is largely restricted to rural locations.

The predicted probabilities for the recent fertility and current enrollment probit models are presented in Table 6.

Alternative Specifications

Tables 7 and 8 examine whether consumption has a nonlinear effect on behavior, such as could be captured by a squared term, and explore the contributions made by child survival rates.

We find little evidence for any important non-linearities in the effects of consumption on fertility or schooling in rural areas (Table 7). Fertility remains a normal good throughout the consumption range (the downward turning point of the quadratic formulation occurs at consumption levels outside the rural range), although the elasticity of cumulative fertility at the mean rises somewhat to .097. In regard to rural schooling, the effect of consumption is positive throughout the range of consumption (the coefficients are misleading in that regard) and the squared consumption terms adds little of substantive importance to our understanding.

By contrast, in urban areas (Table 8) the addition of a squared term in consumption does bring out non-linear effects of some substantive importance. The effect of consumption on fertility is positive up to the 70th percentile of the urban consumption distribution, but then turns negative at higher levels of permanent income. A similar effect is evident for recent fertility, although here the downward turning point does not occur until the upper 10 percent of the consumption distribution is reached. This is evidence — if admittedly somewhat fragile evidence — suggesting that fertility behaves as a normal good up to a certain permanent income threshold, and then turns inferior in respect to income.

The results having to do with child survival rates are striking, although a note of caution is in order here as well. Recall that the survival measure is constructed from 1988 census counts, by commune or sous-prefecture, of the ratio of children surviving to children ever born. Table 6 shows that within rural areas, the survival rate is negatively associated with cumulative fertility, and positively associated with schooling. The fertility elasticity is on the order of -.54 when evaluated at the mean. Note too that no effect is evident with respect to recent fertility. The size of the elasticity, the absence of a strong effect on recent fertility, and the apparently strong effect on cumulative fertility, all suggest that the mechanism linking child survival to fertility has to do with the truncation of breastfeeding caused by a child death (Lloyd and Ivanov, 1988).

Table 6. Predicted Probabilities of Recent Fertility and Current Enrollment: Rural and Urban Sub-Samples

	RURAL		URBAN	
	Women: Any births last 5 years	*Children: Current Enrollment*	*Women: Any births Last 5 years*	*Children: Current Enrollment*
Women's Education				
None	[.674]	[.276]	[.667]	[.469]
Any Primary	.688*	.381	.579	.573
Beyond Primary	.733*	.417*	.480	.669
Residence				
Abidjan			.567	.514
Other Urban			[.626]	[.509]
Rural East Forest	.672*	.325		
Rural West Forest	.658*	.326		
Savannah	[.696]	[.196]		
Ethnicity				
Northern Mande	[.709]	[.201]	[.566]	[.466]
Akan	.689*	.324	.557	.558
Krou	.694*	.390	.612	.541
Southern Mande	.596	.321	.586	.594
Voltaic	.669*	.177*	.640	.486*
Other	.748*	.139	.643	.464*
Sex				
Male		[.342]		[.545]
Female		.221		.478

Notes: Omitted category shown in brackets [].
* the contrast to the omitted category is *not* significant.

Source: Average predicted probabilities from the probit models of Tables 3 and 4, calculated as:

$$\hat{P}_k = (1/N) \sum_{i}^{N} \Phi\left(\sum_{j \neq k} x_{ij}\hat{\beta}_j + \hat{\beta}_k\right)$$

where k refers to the covariate in question and the observation subscript i ranges over the full sample (i.e, all rural or all urban observations). This formulation allows covariates j other than covariate k (except for those in the category of dummy variables being considered, which are set to zero) to take on their sample values x_{ij}. Thus, when all ethnicity dummies are set to zero, we obtain the predicted probability for the omitted category of Northern Mande; to calculate the Akan prediction, we set all ethnicity dummies to zero except for the Akan dummy; and so on. Note that this is different than selecting only the sub-sample of Northern Mande or Akan, in that the other covariates are not restricted to the values that they take for such sub-samples.

Table 7. Cumulative Fertility and Cumulative Schooling: Alternative Specifications, Rural Sample (T-statistics in parentheses.)

	Women				*Children*					
	Cumulative Fertility (OLS)		*Any Births Last 5 Years (Probit)*[a]		*Cumulative Schooling (OLS)*		*Current Enrollment (Probit)*		*Projected Completed Schooling*[b] *(ordered probit)*	
	(1)	*(2)*	*(1)*	*(2)*	*(1)*	*(2)*	*(1)*	*(2)*	*(1)*	*(2)*
Women's Education[c]										
Any Primary	-.114	-.098	-.023	.047	.409	.123	.498	.367	.639	.532
	(0.60)	(0.51)	(0.22)	(0.44)	(2.25)	(0.69)	(5.79)	(4.20)	(6.26)	(5.14)
Beyond Primary	-.421	-.507	.176	.206	.100	-.024	.549	.484	.670	.670
	(1.04)	(1.25)	(0.79)	(0.92)	(0.16)	(0.04)	(1.83)	(1.55)	(1.58)	(0.96)
Consumption per Adult	1.784	.413	-1.032	0.66	-3.677	.565	.027	.277	.275	.285
	(1.00)	(5.01)	(0.85)	(1.27)	(2.59)	(9.36)	(0.04)	(8.40)	(9.75)	(12.68)
Consumption, Squared	-.053		.043		.164		.010			
	(0.76)		(0.90)		(2.98)		(0.74)			
Residence[d]										
Rural East Forest	.763	.656	-.055	-.082	1.386	1.152	.602	.498	.771	.646
	(5.62)	(4.51)	(0.66)	(0.87)	(14.24)	(10.65)	(11.25)	(8.24)	(16.34)	(12.25)
Rural West Forest	.086	.237	-.200	-.128	1.448	.948	.673	.501	.806	.514
	(0.61)	(1.39)	(2.26)	(1.21)	(12.82)	(7.30)	(11.28)	(7.13)	(14.97)	(7.99)
Survival Rate	-3.124	-4.734	1.126	-.012	3.445	2.056	-.089	-.125	1.234	.759
	(2.69)	(3.76)	(1.54)	(0.02)	(3.78)	(2.15)	(0.18)	(0.24)	(3.10)	(2.00)
Ethnicity[e]										
Akan		.028		-.067		1.070		.461		.621
		(0.13)		(0.50)		(6.84)		(4.98)		(7.25)
Krou		-.242		-.049		2.101		.683		1.086
		(0.95)		(0.31)		(11.42)		(6.85)		(11.38)
S. Mande		-.558		-.365		.944		.449		.632
		(2.50)		(2.65)		(5.72)		(4.66)		(7.45)
Voltaic		-.579		-.136		.080		-.111		.006
		(2.50)		(0.95)		(0.46)		(1.02)		(0.06)
Other		-.133		.137		-.506		-.300		-.348
		(0.54)		(0.89)		(2.69)		(2.70)		(3.37)
Female					-1.105	-1.093	-.443	-.453	-.549	-.578
					(14.05)	(14.35)	(10.69)	(10.71)	(14.64)	(15.02)
R^2	.409	.413			.285	.330				
F or χ^2	116.9	92.4	346.6	364.7	134.2	130.9	1040.7	1246.3	787.8[f]	1209.4[f]
(p-value)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Observations	2381	2381	1847	1847	5067	5067	5067	5067	5067	5067

Constant terms, women's and children's age coefficients are not shown.

Notes:

a. Women aged 50 and over omitted.
b. Ordered probit model with no allowance for right-censoring.
c. Omitted category: No schooling.
d. Omitted category: Savannah.
e. Omitted category: Northern Mande.
f. Test against null model with cut-point parameters α and child's age.

Table 8. Cumulative Fertility and Cumulative Schooling: Alternative Specifications, Urban Sample (T-statistics in parentheses.)

	Women				*Children*					
	Cumulative Fertility (OLS)		*Any Births Last 5 Years (Probit)*[a]		*Cumulative Schooling (OLS)*		*Current Enrollment (Probit)*		*Projected Completed Schooling*[b] *(Ordered Probit)*	
	(1)	*(2)*	*(1)*	*(2)*	*(1)*	*(2)*	*(1)*	*(2)*	*(1)*	*(2)*
Women's Education[c]										
Any Primary	-.043	-.037	-.310	-.291	.727	.436	.395	.317	.478	.310
	(0.33)	(0.27)	(3.50)	(3.17)	(5.38)	(3.23)	(5.50)	(4.33)	(6.61)	(3.80)
Beyond Primary	-.701	-.681	-.607	-.564	1.056	.730	.724	.643	.886	.739
	(5.15)	(4.87)	(6.68)	(6.03)	(6.66)	(4.62)	(8.07)	(7.02)	(8.26)	(6.69)
Consumption per Adult	4.300	4.381	2.112	2.308	4.781	4.202	.941	.855	1.441	1.473
	(3.11)	(3.16)	(2.08)	(2.27)	(3.42)	(3.05)	(1.14)	(1.03)	(5.01)	(6.26)
Consumption, Squared	-.157	-.160	-.073	-.080	-.154	-.137	-.022	-.020	-.041	-.044
	(3.04)	(3.09)	(1.94)	(2.11)	(2.94)	(2.65)	(0.71)	(0.64)	(3.67)	(4.01)
Residence[d]										
Abidjan	.034	.022	-.089	-.111	.037	.166	-.330	-.312	-.033	-.022
	(0.19)	(0.12)	(0.69)	(0.85)	(0.84)	(0.93)	(3.35)	(3.11)	(0.33)	(0.26)
Survival Rate	-4.608	-4.490	-.089	-.870	3.764	3.065	3.937	3.971	2.028	2.206
	(2.47)	(1.89)	(0.67)	(0.65)	(2.04)	(1.67)	(3.90)	(3.84)	(2.17)	(2.90)
Ethnicity[e]										
Akan		.035		-.030		.840		.267		.425
		(0.22)		(0.26)		(5.36)		(3.06)		(5.02)
Krou		.090		.142		.985		.212		.624
		(0.22)		(1.03)		(4.94)		(1.91)		(5.49)
S. Mande		.233		.054		.850		.416		.562
		(1.08)		(0.37)		(3.99)		(3.45)		(4.52)
Voltaic		.151		.231		-.325		.082		-.034
		(0.74)		(1.57)		(1.67)		(0.76)		(0.33)
Other		.166		.259		-.332		-.042		-.193
		(1.00)		(2.25)		(2.13)		(0.49)		(2.32)
Female					-.624	-.617	-.218	-.224	-.343	-.365
					(6.71)	(6.76)	(4.33)	(4.41)	(6.78)	(7.14)
R^2	.493	.494			.474	.496				
F or x^2	143.4	103.6	408.2	421.3	198.7	160.0	992.9	1026.5	380.6[f]	511.8[f]
(p-value)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Observations	1929	1929	1741	1741	3108	3108	3108	3108	3108	3108

Constant terms, woman's age and children's age coefficients not shown.

Notes:

a. Women aged 50 and over omitted.
b. Ordered probit model with no allowance for right-censoring.
c. Omitted category: No schooling.
d. Omitted category: Savannah.
e. Omitted category: Northern Mande.
f. Test against null model with cut-point parameters α and child's age.

Note that in rural areas, child survival rates are positively associated with cumulative schooling. The elasticity at the mean is 1.12. The meaning of this association, however, is not entirely clear. As discussed in Section II, it could represent a greater willingness among parents to invest in human capital when child survival is more assured; or it might reflect the strain on family resources produced by larger-than-required numbers of surviving children in high-mortality environments; or the association could simply represent omitted factors associated with child health that have some correlational or behavioral link to schooling decisions.

It is perhaps surprising that similar findings are in evidence within urban areas, as shown in Table 8. As in rural areas, schooling elasticities in the urban sector are positive with respect to child survival, and the cumulative fertility elasticities are negative. The elasticity of cumulative fertility is -1.27 at the mean, which suggests a more-than-compensating drop in fertility given an increase in child survival, such that the net reproduction rate would tend to fall if survivorship improved. The cumulative schooling elasticity is .924 at the mean, and that of current enrollment is 2.58; the latter seems implausibly large.

The Quantity-Quality Tradeoff Revisited

Let us sum up the results presented above in Figures 19 to 21. We return here to the depiction of the quantity-quality tradeoff in terms of a locus of two endogenous variables. On the vertical axis of Figures 19 to 21, we indicate the predicted number of children ever born, using coefficient estimates from the cumulative fertility models of Tables 6 and 7 and taking as given the distribution of exogenous characteristics in the LSMS sample. The predictions based on these sample characteristics are evaluated setting the woman's age to 40-45, in order that the predictions will approximate completed lifetime fertility. On the horizontal axes, we depict the projected years of schooling for a representative child born to a woman with these sample characteristics. The predictions are drawn from the ordered-probit, projected completed schooling models of Tables 6 and 7. One prediction is made if the child in question is female, and another if the child is male. These predictions are evaluated setting the child's age to 25 years, so as to approximate expected completed years of schooling. (The results to follow would be very similar if we had examined the predicted proportions of children with secondary schooling, for example.)

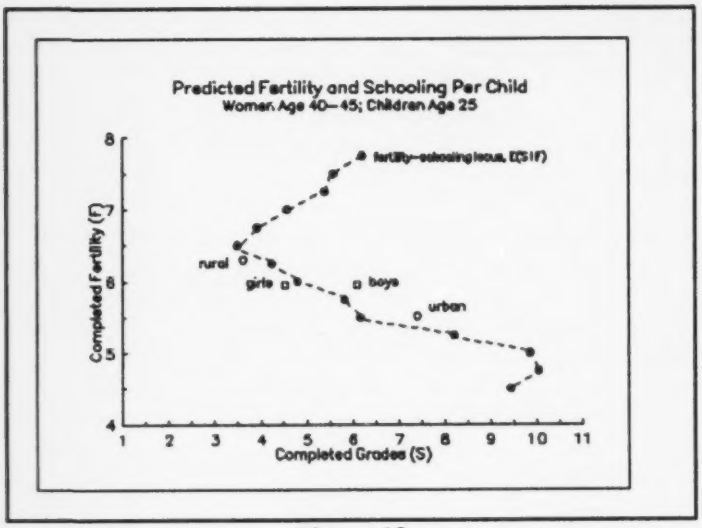

Figure 19

First consider Figure 19. We can envision the full space between the axes as being filled with predicted data points.[14] How should the joint distribution of these two endogenous variables be summarized to show evidence of a quantity-quality tradeoff?

We suspect that these estimated survival rate effects may represent factors other than survival per se, but they are nevertheless intriguing. If taken literally, they suggest that investments in child health and survival may have a spill-over influence expressed in fertility reductions and (perhaps) improvements in schooling.

14. A single such data point is constructed as follows. Considering a given woman i with exogenous covariates X_i, we calculate a pair of predicted values

$$\hat{F}_i = X_i\hat{\beta}_F$$

$$\hat{S}_i = X_i\hat{\beta}_S$$

where X_i comprises all covariates included in the models of Tables 6 and 7, with age being set to 40 and 25 for the fertility and schooling equations respectively. We let h(X) represent the distribution of X in the LSMS samples.

One summary device is indicated in the fertility-schooling locus of Figure 19. This gives the expected value of schooling conditional on the level of fertility.[15] Another way to summarize the information is to plot the predicted mean values of fertility and schooling for different socioeconomic groups.[16] Thus, we have indicated on the graph the mean levels of fertility and schooling for urban residents, for rural residents, and for female and male children.[17]

The schooling-fertility locus takes a puzzling and peculiar shape. In the upper portion of Figure 19, the locus seems to suggest a positive relationship between lifetime fertility and child schooling. We see that this portion of the curve lies near to the rural mean values for fertility and schooling, and on this basis, we might surmise that the positively-sloped portion of the "tradeoff" pertains to rural areas. The lower part of Figure 19 shows a predominantly negative association between fertility and schooling; perhaps this is the relationship that holds sway in urban areas. Overall, then, we might suspect that Figure 19 has superimposed two very different relationships of opposite sign.

---

15. More formally,

$$E\,(S|F) \;=\; \frac{\displaystyle\int_{X:\hat{F}=F} \hat{S}(X)h(X)dX}{\displaystyle\int_{X:\hat{F}=F} h(X)dX}$$

where

$$\{X:\hat{F}=F\}$$

represents the set of covariate values X yielding a given predicted value for fertility. (In practice we construct ranges of values for F.)

16. This is simply the pair of conditional mean predictions

$$E\,(\hat{F}(X), \hat{S}(X)\,)\,|\,X_1=x_1$$

where X_1 is the covariate category under consideration, e.g., all urban residents, and the full set of covariates is written as (X_1,X_2).

17. In the figures to follow, the predicted fertility level is always the same when girls and boys are compared; only the predicted schooling levels differ. In effect, we assume that the sex ratio at birth is independent of the mother's fertility level. Note also that the vertical axes range from a lower limit of 4 to an upper limit of 8. The regression predictions all lie within this range, which is plausible for this high-fertility population. In particular, no woman was predicted to have 0 children as of the end of her reproductive years.

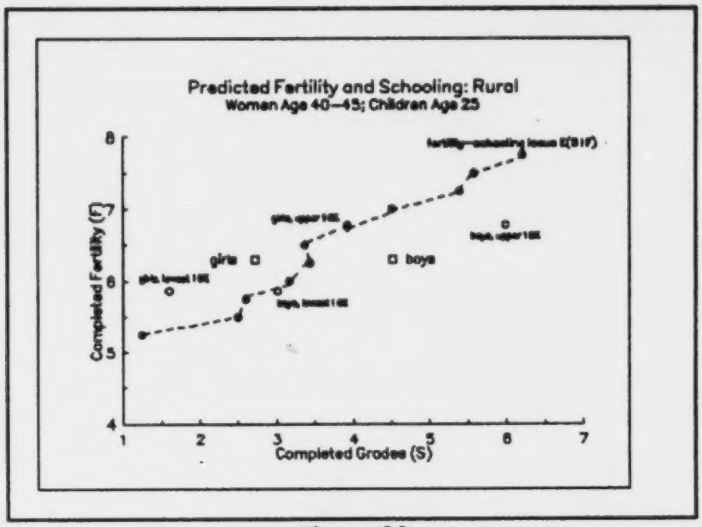

Figure 20

This suspicion is confirmed when separate plots are produced for rural and urban areas. Figure 20 sheds light on the relationship between child quantity and quality in rural areas; as suspected, the positive relation dominates. The male and female means appear in the center of the figure, and sex-specific values for families in the lowermost and uppermost 10 percent of the consumption distribution are also shown. The general upward slope of the fertility-schooling locus, as well as the sequence of mean values for boys and girls separately, suggest the importance of permanent incomes to lifetime fertility and schooling investments in rural areas. We should also recall that the permanent income effects may be overstated; it is possible that the true curve is flatter than what is shown here.

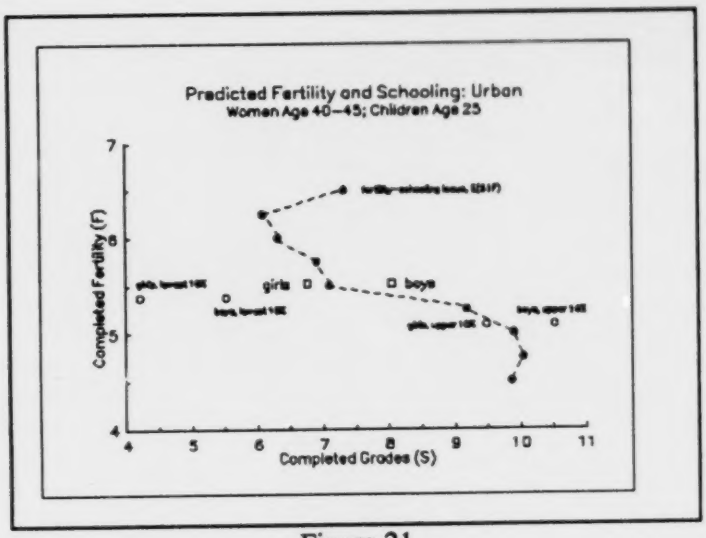

Figure 21

Figure 21 for urban areas shows that the conventional, negatively-sloped fertility-schooling locus dominates. The effects of income are rather mild. For each sex, these income effects are visible in the slight curvilinearity as children in the bottom 10 percent of the consumption distribution are compared to those at the mean and to those in the upper 10 percent.

In short, these findings suggest that the urban and rural economic and policy environments of Côte d'Ivoire have strikingly different implications for the tradeoff between child quantity and quality. The findings therefore underscore the importance of urbanization to long term development prospects, in which reductions in labor force growth and increases in human capital per worker are fundamental. They also hint at the potential role of a policy variable — family planning service delivery — that of necessity has gone unmeasured in our research. Recall that to date, family planning has been available only through private sector sources in Côte d'Ivoire, and for the most part these have been restricted to urban areas. Perhaps it is the availability of a means to restrict fertility in urban areas that has facilitated the tradeoff between quantity and quality.

The Price of Schooling

We close our analysis of the quantity-quality tradeoff with an examination of another policy variable that may have a direct effect on schooling and, some would argue, an important indirect effect on fertility decisions. This is the exogenous price of child schooling.

Figure 22 presents mean values for school expenditures according to the child's age, calculated from the LSMS sample of enrolled resident children. Average school expenditures per enrolled resident child for all ages amounted to 37,897 CFA.[18] One curve represents total expenditures per child, expressed in thousands of CFA, and the other curve represents the ratio of per child expenditures to consumption per adult. The curves are strikingly similar in shape. The right-most curve, representing expenditures relative to consumption, shows that expenditures amount to only 5 percent of adult consumption for children of ages 5-7, but the figure rises to over a third of adult consumption for children in their twenties. Clearly these are significant amounts whether expressed in absolute or relative terms.

Given that school costs are substantial, how much difference do they make to enrollment and fertility? To answer this question, we must confront an awkward feature of the LSMS data. The costs of enrollment are not known for all children, but only for children who are enrolled; and further, not for all enrolled children, but only for those who are resident in the household. To put this in another way, school prices are known only for a highly selected sub-sample of children.

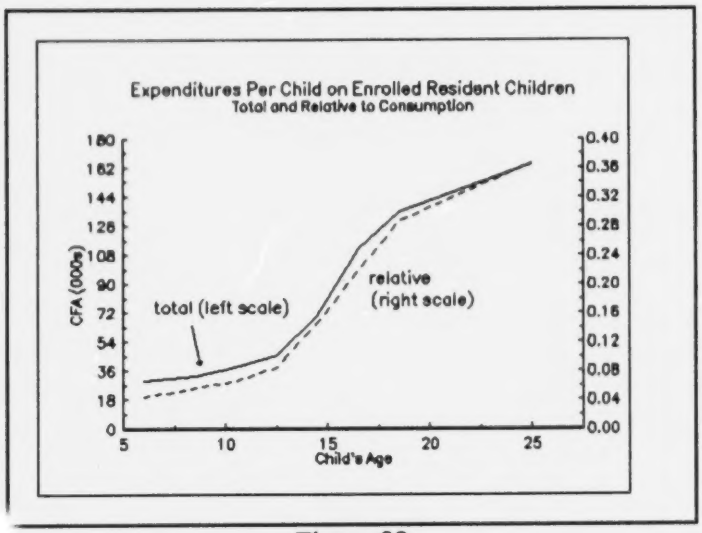

Figure 22

18. Or US$110 at the 1986 exchange rate of 346 CFA/dollar.

There is no straightforward solution to this selectivity problem. We proceed using a method outlined in Maddala (1983) and Heckman (1979), in which the probability that a child is resident and enrolled (i.e., is in the sub-sample for which school expenditures are known) is modelled as a function of covariates and instrumental variables. The results of this first stage are used to form a selectivity correction factor, which enables a cost-of-schooling function to be estimated without large-sample selectivity bias. The cost-of-schooling regression includes only exogenous covariates that vary by sample cluster; we add the child's age to allow for changes in school costs by grade level. The idea is to include only the covariates that could influence the exogenous cost of enrollment facing parents. (For instance, we do not include the sex of the child in the body of the regression; it is included only indirectly in the selectivity correction term.) The predicted values from this regression are then used to construct a predicted schooling cost variable, which is inserted into the final structural enrollment regression.

As are all instrumental-variables approaches, this approach is vulnerable to multicollinearity. In particular, the striking age pattern in costs evident in Figure 22 is largely retained in the predicted costs variable. This makes it difficult to distinguish the true effects of school costs on enrollment from any unmeasured effects of age that might be captured in age-specific dummy variables.

The enrollment results we present in Table 9 below substitute the child's age and age squared for the full set of age dummies used in earlier tables. With this change in functional form, the effects of the school price variable on rural and urban enrollments appear to be strongly negative. The elasticities implied are -1.41 for rural areas and -.76 for urban areas. These can be compared with the range of -.05 to -.61 for rural Peru given in Gertler and Glewwe (1989: Table 7), and to their more tentative lower bound estimate of -1.17 incorporating selectivity (see their Table A.4). Elasticities greater than -1 (in absolute value) imply that a marginal increase in exogenous school costs (e.g., through higher school fees) would result in lower total revenues.

The Côte d'Ivoire findings are consistent with a greater anticipated payoff to schooling in urban areas, but the estimates are not especially robust. The introduction of dummy variables for the child's age removes the significance of the estimated price effects, as does any further separation of the samples into children of primary ages and post-primary ages.

We should note here that the education infrastructure variables, which measure aspects of access to schooling, are statistically significant in both rural and urban areas. However, as also reported by Glewwe (1988), they do not make a greatdeal of difference to the estimated probabilities of enrollment. It seems unlikely, therefore, that improvements in the access-to-schooling variables measured here could fully compensate

households for increases in school costs.[19] (See Gertler and Glewwe, 1989, for further discussion in the context of Peru.)

Do schooling costs have spill-over implications for fertility? We see little evidence of this in Côte d'Ivoire. The schooling price variables are individually insignificant; indeed, the set of schooling price and access variables makes no discernible difference to fertility in either the rural or urban sub-samples, to judge by a chi-square test. We think that it would be premature to dismiss the possibility of such spill-over influences, however. Our test is based on a schooling price variable that is in essence little more than an age profile; it does not display sufficient cross-sectional variation, net of age, to make a strong showing. If the schooling prices variable could be constructed with areal-level or school-level data, as are available for Ghana (Oliver, 1992), a great deal more might be learned.

19. Our experiments with various quality-of-schooling measures, constructed from the rural community or inspectorate data listed in Table 1, gave disappointing results (not shown). Measures such as student-teacher ratios or indices of schooling problems faced by the community generally seemed to tap aspects of demand rather than supply constraints or quality. For instance, with all else equal, rural communities with a perceived shortage of teachers or classrooms tended to have higher-than-typical enrollment levels. Communities located in primary school inspectorates with high student-teacher ratios also had higher-than-typical enrollments.

Table 9: Models Including the Price of Schooling
(T-statistics in parentheses)

	Rural		Urban	
	Women: Any births Last 5 years[a]	*Children: Current Enrollment*	*Women: Any Births Last 5 Years*[a]	*Children: Current Enrollment*
Women's Education[b]				
Any Primary	.068	.341	-.285	.348
	(0.62)	(3.90)	(3.10)	(4.73)
Beyond Primary	.216	.405	-.544	.668
	(0.96)	(1.29)	(5.69)	(7.22)
Consumption per Adult	.069	.258	2.359	.429
	(1.31)	(7.60)	(2.28)	(0.51)
Consumption, Squared			-.082	-.003
			(2.12)	(0.10)
Residence[c]				
Abidjan			-.199	.144
			(1.19)	(1.23)
Rural East Forest				
Rural West Forest	.029	.346		
	(0.20)	(5.35)		
	-.037	.419		
	(0.28)	(5.59)		
Survival Rate	.127	-.020	-.217	3.875
	(0.15)	(0.04)	(0.15)	(3.68)
Ethnicity[d]				
Akan	-.026	.424	-.037	.333
	(0.19)	(4.41)	(0.33)	(3.77)
Krou	-.063	.662	.142	.244
	(0.39)	(6.20)	(1.03)	(2.18)
Southern Mande	-.377	.381	.050	.423
	(2.58)	(3.75)	(0.34)	(3.51)
Voltaic	-.159	-.097	.241	.131
	(1.07)	(0.86)	(1.62)	(1.22)
Other	.160	-.373	.263	.013
	(1.02)	(3.32)	(2.27)	(0.15)
Female		-.460		-.233
		(10.72)		(4.56)
No Primary School	.123	-.156		
	(0.81)	(1.34)		
Distance to Primary	-.031	-.076		
	(0.92)	(2.32)		
Year Primary Built	.008	-.002		
	(1.68)	(0.63)		
No Secondary School			-.040	-.093
			(0.39)	(1.11)
Distance to Secondary	.001	-.005		
	(0.80)	(4.41)		
Year Secondary Built	.005	-.009	.008	-.017
	(1.00)	(2.94)	(2.00)	(5.58)
Schooling Prices[e]	7.18×10^{-6}	-8.82×10^{-6}	-9.43×10^{-7}	-9.01×10^{-6}
	(0.61)	(8.35)	(0.31)	(8.15)
X^2	370.4	1363.4	426.1	1058.2
(p-value)	(.000)	(.000)	(.000)	(.000)
Observations	1847	5067	1741	3108

Constant terms, woman's age and children's age coefficients not shown.

Notes:
a. Women aged 50 and older omitted.
b. Omitted category: No schooling.
c. Omitted category: For rural areas, Savannah; for urban, Other urban.
d. Omitted category: Northern Mande.
e. Estimated from a regression with dependent variable being school expenditures, explanatory variables including child's age and a set of cluster- or higher-level variables. The expenditures regressions include a correction due to Heckman (1979) for sample selectivity bias. The predicted values of school expenditures, which vary according to the age of the child, are entered in the current enrollment models above. For the fertility models above, the predicted value of school expenditures was evaluated at (child's) age 12.

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Conclusion

This paper has produced evidence suggesting that two very different relationships link fertility and child schooling in Côte d'Ivoire. In rural areas, a positive tradeoff appears, a finding consistent with much of the early research on fertility and schooling in Africa. Urban areas, by contrast, are characterized by the negatively-sloped tradeoff that appears in Southeast Asia and elsewhere in the developing world.

With respect to other sectoral and policy issues, the findings of a tradeoff in urban areas of Côte d'Ivoire reaffirms the significance of urbanization to demographic transitions. Yet it is not entirely clear why urban residence matters. One aspect must have to do with the economic benefits of schooling, which are perhaps more clearly visible and persuasive in urban settings than in rural. Access to schooling, and to family planning, is also facilitated by urban residence.

It is also interesting that women's schooling has a context-dependent effect on fertility and the schooling of children. There is little evidence that women's schooling makes a difference to fertility in the rural areas of Côte d'Ivoire; and even the influence on children's schooling is somewhat tenuous. In urban areas, by contrast, the effect on fertility is clearly negative and the influence on children's schooling is clearly positive. The difference between these rural and urban results may have to do with selective out-migration of better-educated women from rural areas, such that women who remain in these areas have uniformly low levels of education. One wonders whether investments in women's education in rural areas might therefore leave rural fertility essentially unchanged, while encouraging greater rural-to-urban migration and lower urban fertility.

We do not find any convincing evidence that increases in school costs in Côte d'Ivoire will have a significant bearing on levels of fertility. Indeed, if we return to Figure 1 of the paper and ask how our findings about price effects would be represented there, the implication is that schooling price increases would be reflected in a movement from point A to point C: little change in fertility, but (considering the elasticity estimates) some considerable reduction in school enrollments.

However, this last finding is tentative, for as discussed above, the constructed school price variables lack the cross-sectional variation needed to make any precise measurements of impact on enrollments. Nevertheless, the large enrollment elasticities are disturbing. They raise some doubts about the wisdom of any further shifting of school costs to the private sector. Clearly this is an area in which further work is required.

Finally, we are intrigued if not wholly persuaded by the apparent effects of child survivorship on schooling. It would seem that in addition to the direct impact of investments in child health on child survivorship, there may well be an indirect benefit expressed in greater educational attainment. This possibility deserves further exploration.

Appendix 1
The Ordered-Probit Model for Projected Completed Schooling

The model for projected completed schooling combines information on the number of grades a child has completed as of the time of the LSMS surveys with data on school enrollment at survey. Let S_i represent the level of schooling that will eventually be attained by child i. Call $P(S|\alpha,X\beta)$ the probability distribution of S given covariates X and associated coefficients α and β. S is of course discrete-valued, taking on values 0,1,2..., and P(S) is a discrete distribution.

The difficulty in regard to estimating P(S) is that S itself goes unobserved for a high proportion of children in the sample. The S_i data for children who are still enrolled as of the survey dates are right-censored, in the sense that eventual educational attainment S_i is not yet known for such children. All that can be said is that, whatever S_i may turn out to be, it must either equal or exceed the level of attainment achieved as of the survey date.

Let C_i represent the grade completed as of the survey date, and let E_i represent enrollment status at survey, where 1 indicates enrolled and 0 not enrolled. E can be then regarded as an indicator of right-censoring. That is, if $E=1$ the level of schooling completed as of the survey date c_i provides a lower bound on the level that will eventually be completed, such that $S_i \geq c_i$. Children who are not enrolled at survey can be presumed to have completed their schooling, so that for these children $S_i=c_i$.

Of course this last assumption, whereby non-enrollment is equated with completion of schooling, is problematic for children of ages 7 or younger. These young children may have $C_i=0$ and $E_i=0$ simply because they have not yet entered school. To guard against this possibility, we omit from the sample all children aged 7 or younger who have no schooling ($C_i=0$) and who are not enrolled ($E_i=0$), on the grounds that for them, $C_i=0$ and $E_i=0$ provide no information as to eventual educational attainment.

Even for older children, however, a spell of non-enrollment need not signal the end of the educational career. A child may be withdrawn from school temporarily, under the expectation that he will later resume his studies. The LSMS survey contains a question as to whether non-enrolled children expect to return to school in the future. In principal at least, such information could be used to refine the estimator developed here. But as it happens, this question is addressed only to the children who currently reside in the household. As noted in the text, even at ages under 7 some 16 percent of children live apart from their mothers; the figure increases to 28 percent among children aged 12-13, and to 50 percent among children 16-17. The question on resumption of schooling is therefore of somewhat limited value.

In short, the approach we develop here produces estimates of completed schooling that may be downwardly biased to a degree. It is unclear whether incorporating data on the resumption of schooling would improve the situation, as these data are available only for an unrepresentative sub-sample of still-resident children. Nevertheless, we intend to investigate the matter in more detail in future work.

We estimate the discrete distribution P(S) using an ordered-probit specification with an allowance for right-censoring. In this approach, the probability that the level of completed schooling S=s is defined by areas under a normal probability density function between cut-points α_{s-1} and α_s. The density function in question –call it $f(S|X\beta)$– has a mean equal to $X\beta$ and a variance that is normalized to unity.

Figure A1 below may help to clarify the approach. Suppose that two children are under consideration, one with covariates X_0 and the other with covariates X_1. Normal density functions f with means $X_0\beta$ and $X_1\beta$ are graphed in the figure, along with cut-point parameters α_0, α_1 and α_2.[20] For the child with covariates X_0, the probability of no schooling (S=0) is represented as the area p_0 under the curve $f(S|X_0\beta)$ to the left of cut-point α_0. The probabity of one year of schooling, S=1, is represented by the area under the curve between α_0 and α_1; and so on.

As the figure is drawn, the child with covariates X_1 has a density function that is shifted to the right relative to that of the child with covariates X_0. This means that the probabilities associated with 0 and 1 years of schooling, p_0' and p_1', are reduced in magnitude, whereas the probability associated with a higher level of schooling, p_3' in this example, is increased. To put this in another way, if the coefficient β_k associated with covariate X_k is positive, then an increase in X_k increases the likelihood of greater educational attainment.

The estimation of $P(S|\alpha,X\beta)$ proceeds by maximum-likelihood methods, with both the cut-points α and the coefficients β being estimated. To form the likelihood function, the probabilities p_s are represented in the form

$$p_s = \begin{cases} \Phi(\alpha_0 - X\beta) & \text{for } S = 0 \\ \Phi(\alpha_s - X\beta) - \Phi(\alpha_{s-1} - X\beta) & \text{for } S \in (1,2,..,s_{top}) \\ 1 - \Phi(\alpha_{s_{top}} - X\beta) & \text{if } S > s_{top} \end{cases} \quad (4)$$

where $\Phi()$ is the cumulative standard normal distribution and s_{top} is the level of schooling beyond which we aggregate the p_s probabilities.[21]

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20. In considering the distribution of schooling, we make allowance for some 13 α parameters; fewer are displayed here in order to simplify the exposition.

21. In our application, we consider single years of schooling up to 12 years, and group all higher levels of attainment into the category 13+. That is, $s_{top}=12$.

Given all this, the probability associated with having C=c completed years of schooling and being currently enrolled (E=1) is

$$1 - \Phi(\alpha_{c-1} - X\beta) \qquad (5)$$

for $c \geq 1$. The probabilities for having C=c completed years and not being enrolled (E=0) are given by the appropriate expressions in equation (1) above with α_c substituted where α_j appears.

Figure A2 shows the results of a baseline estimation with the child's age entered as the sole X covariate. The figure compares the actual distribution of years of schooling completed as of the LSMS survey dates (that is, C), with the predicted distribution of schooling $P(S|\alpha,X\beta)$ based on C, enrollment rates E, and age. The allowance made in the estimation for right-censoring (cases with E=1) causes the predicted distribution of schooling P(S) to be shifted to the right, relative to the distribution of years completed as of the survey date. This is precisely what we would expect. The means of the two distributions are 2.78 years and 5.24 years. Both distributions show a substantial proportion of children with no years of schooling (grade 0), with completed primary (grade 6), and with completed early secondary schooling (grade 10). The predicted schooling model also suggests that some 10 percent of children will proceed as far as 13 years of schooling. Neither distribution contains large proportions of children with incomplete primary or incomplete secondary schooling; this is consistent with what is known about enrollment patterns in Côte d'Ivoire (Glewwe, 1988).

Finally, note that the predicted distribution of schooling P(S) bears no resemblance at all to a normal distribution. So long as the cut-points α are allowed to vary in the estimation, the assumption of normality in equations (1) and (2) amounts to little more than a convenience. As is the case here, the ordered-probit method can in general produce decidedly non-normal distributions for the dependent variable being modelled.

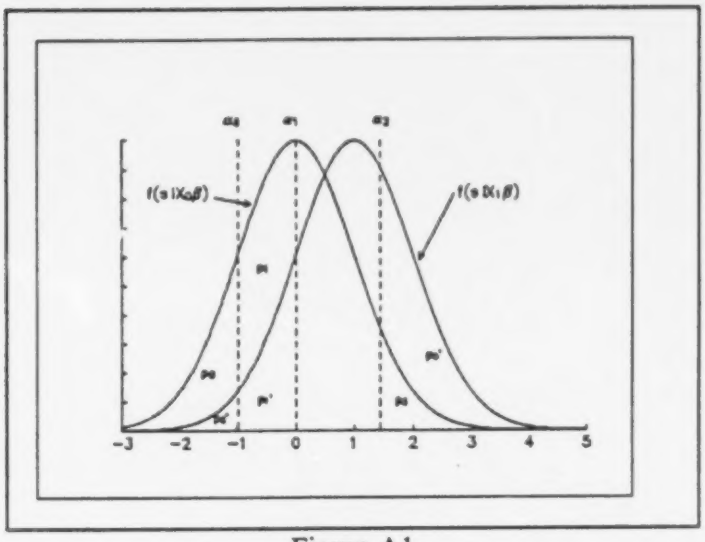

Figure A1

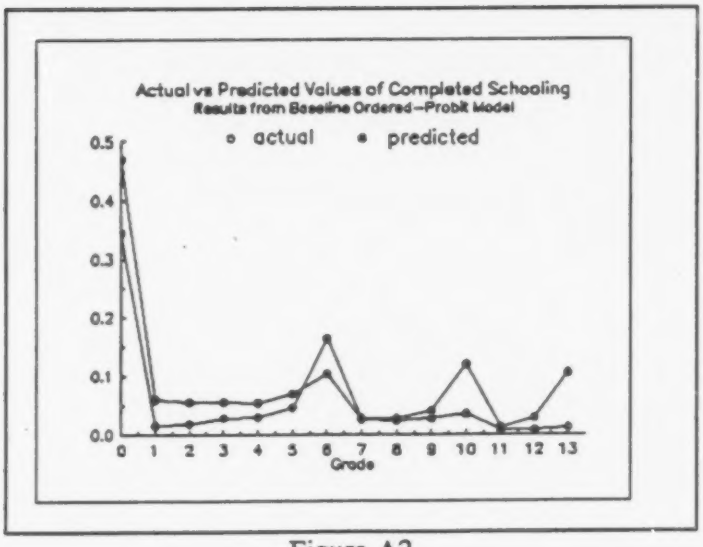

Figure A2

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Appendix 2
Assessing the Exogeneity of Consumption per Adult

In this appendix we weigh the evidence regarding one key variable in the analysis, the log of consumption expenditures per adult. What is at issue is the degree to which this variable may be correlated with the error terms in the fertility or schooling equations. If such a correlation exists, then we would consider the consumption variable to be statistically endogenous. Its presence in the regression equations would impart a bias not only to its own regression coefficient, but also, in general, to all other estimated coefficients.

There are substantive grounds for concern. Benefo and Schultz (1992) provide an excellent discussion of the issues, and we would single out one possibility for special attention. In a situation in which older children work and make a contribution to household income in cash or in terms of the value of labor, prior fertility may be an important determinant of the level of consumption per adult, that is, permanent income. What we seek is to measure the influence of permanent income on fertility, but the true effect may well be clouded by such reverse causation.

In her analysis of cumulative fertility in the 1985 wave of the Côte d'Ivoire LSMS, Ainsworth (1990) applied the Hausman (1978) exogeneity test, a test based on the use of instrumental variables, to assess the exogeneity of consumption per adult. She found that an assumption of exogeneity could not be rejected at the 95 percent confidence level. Yet Benefo and Schultz (1992: see their text and Appendix D), using the 1985-87 waves of these data, a different set of instruments and a slight redefinition of the dependent variable (cumulative fertility among women having at least one child), found that exogeneity could be rejected at the same level of confidence considered by Ainsworth.

The differences in findings may well be attributable to differences in the set of instrumental variables employed. In selecting the instruments, the researcher confronts a practical dilemma: the instruments must be exogenous, and yet at the same time, must be sufficiently highly correlated with the (potentially) endogenous variable in question to produce reliable predictions of that variable. All too often, candidate variables that perform well in respect to predictive ability must be rejected from the set of instruments because they are at least arguably endogenous themselves. Furthermore, the instrument set cannot be dominated by the exogenous variables that are already represented in the structural equation. There must be additional exogenous variables available to serve as instruments, and these must make an important additional contribution to the prediction of the endogenous variable (i.e., consumption). Otherwise both the identifiability of the structural equation and the quality of the structural equation estimates may be compromised by multicollinearity.

We face these generic difficulties in regard to the Côte d'Ivoire LSMS data. The cluster, commune and sous-prefecture data listed in Table 1 of the text would seem to constitute an unusually rich set of instruments. From these we select dummy variables for the survey year, the male agricultural daily wage, census-based measures of the

composition of the male labor force and the full set of community-level price data available from the LSMS price surveys. We augment these with several exogenous variables already represented in the structural schooling and fertility equations, namely, the woman's age, residence, and education.

When taken together, these instruments are only moderately predictive of consumption per adult: the R^2 on the consumption regression is a modest .25. The R^2 can be considerably improved, to .35, by the addition to the instrument set of cluster-level averages of consumption per adult. (The cluster averages are calculated omitting the consumption level of the household in question.) Unfortunately, these cluster consumption averages are themselves suspect on the grounds of endogeneity. It is very likely that unmeasured cluster-level characteristics will appear in the individual household consumption levels as well as in the cluster averages of consumption. If we are to maintain confidence in the exogeneity of the instruments, therefore, it appears that an R^2 of .25 is about the best that can be achieved.

To be sure, Benefo and Schultz (1992: Appendix D) do much better in R^2 terms in their instrumental-variables equation for consumption per adult. But the greater predictive power is produced, it seems, by the addition of various measures of household composition, including the presence of a husband, his education and age, and household assets. The exogeneity of these variables is a matter about which reasonable researchers may disagree; we regard them as being endogenous.

Appendix Table 1 sums up our tests of exogeneity based on the restricted set of instruments, and also provides tests based on the inclusion of cluster consumption averages in the instrument set. The first column of the table presents the uncorrected least-squares or probit estimates of the effect of consumption per adult on fertility and child schooling. We then report the instrumental-variables-based (IV) estimate of this coefficient and provide the p-value of the Hausman exogeneity test. We also present an additional informative criterion by which the simple OLS and probit results can be assessed: do the uncorrected (and potentially biased) estimates lie in a 95% confidence band surrounding the (safer but less precisely-estimated) instrumental variables estimates?

The results are somewhat different for fertility and schooling. In the case of fertility, the uncorrected estimates suggest that consumption per adult exerts a positive and significant influence on fertility overall. Within rural and urban areas, the effect varies in strength but each estimate suggests a positive influence. When these coefficients are estimated by the IV method, however, they are uniformly negative and insignificant. In a way, and particularly for rural areas, this is what one might have suspected if children indeed make a positive contribution to family permanent income. Once the reverse causation from fertility to income is purged via the use of instruments, permanent income itself evidently exerts no important influence on fertility.

The picture is more complex than this explanation suggests, however. A closer inspection of the instruments-based regressions (not presented here) shows that the negative sign of the IV coefficients is due principally to the fact that a woman's schooling is positively and strongly associated with the level of consumption per adult in her household. In the structural equation for fertility, predicted consumption levels are

therefore highly correlated with the woman's education, so that the negative direct influence of education on fertility is spread over the consumption coefficients as well as the education coefficients. This is an aspect of the multicollinearity problem mentioned above. Moreover, Appendix Table 1 shows that once separate fertility equations are specified for rural and urban areas, the uncorrected least-squares and probit coefficients generally lie within the IV confidence bands. The single exception occurs when the instruments include cluster averages of consumption, but here the question of instrument exogeneity puts the test in doubt.

The lessons we extract from these tests, as regards fertility, are (1) that separate urban and rural equations are required, as would be reasonable in any case; and (2) that there is little apparent risk in proceeding with the uncorrected OLS and probit approaches. There is some possibility that the effects of permanent income may be overstated by the uncorrected approaches, but we see little here to suggest that the IV estimates are necessarily any closer to the truth.

The results regarding the schooling equations reinforce these conclusions on the whole. The uncorrected OLS and probit estimates generally lie within the IV confidence bands (again exceptions are more likely in the expanded instrument set) and in some contrast to the case of fertility, there seems here to be no clear pattern of upward or downward bias in the uncorrected OLS or probit coefficients. If one places faith in the instrument set with cluster consumption averages, the pattern is one of downward bias in the uncorrected coefficients.

To sum up, then, we see in these tests a sufficient justification for proceeding without instrumental-variables corrections for the endogeneity of consumption. The assumption of exogeneity has not been decisively sustained, of course, and there remains some risk of bias, but we can find no compelling basis on which to prefer the instrumental-variables alternative.

Appendix Table 1: Exogeneity Tests on Consumption Per Adult (log), With and Without Cluster Averages of Consumption in the Set of Instrumental Variables[1/]

		Instrumental Variables (IV) Models					
		Instruments Exclude Cluster Average			Instruments Include Cluster Average[3/]		
Dependent Variable	Reduced Form Coefficient on (log) Consumption per Adult[2/] (t-stat)	Coefficient (t-stat)	Hausman Exogeneity Test p-value	Is reduced form Estimate in IV Confidence Band?[4/]	Coefficient (t-stat)	Hausman Exogeneity Test p-value	Is reduced form Estimate in IV Confidence Band?[4/]
Fertility (OLS)							
Cumulative Fertility	.232 (4.32)	-.228 (1.08)	.021	No	-.090 (0.67)	.007	No
Any Births Last 5 Years	.114 (3.29)	-.151 (1.19)	0.42	No[5/]	-.105 (1.29)	.006	No
Rural Cumulative Fertility	.368 (4.51)	-.303 (0.83)	.064	Yes	-.233 (1.04)	.001	No
Rural, Any Births Last 5 Years	.066 (1.27)	-.126 (0.59)	.366	Yes	-.176 (1.37)	.036	Yes
Urban, Cumulative Fertility	.083 (1.18)	-.189 (0.79)	.235	Yes	.011 (0.07)	.658	Yes
Urban, Any Births Last 5 Years	.166 (3.45)	-.114 (0.71)	.086	Yes	-.007 (0.07)	.136	Yes
Schooling (Probit)							
Cumulative Schooling	.542 (11.66)	.721 (4.14)	.169	Yes	1.130 (9.61)	.000	No
Current Enrollment	.291 (11.64)	.422 (4.81)	.037	Yes	.421 (7.06)	.014	Yes
Rural, Cumulative Schooling	.593 (10.05)	1.196 (4.85)	.005	No	1.103 (7.05)	.001	No
Rural, Current Enrollment	.276 (8.54)	.246 (1.98)	.941	Yes	.384 (4.88)	.180	Yes
Urban, Cumulative Schooling	.574 (7.91)	.318 (1.36)	.424	Yes	1.118 (6.55)	.000	No
Urban, Current Enrollment	.347 (8.50)	.570 (4.55)	.009	Yes	.458 (4.97)	.025	Yes

Notes:

1/ The instruments include the woman's age and schooling level; residence; the male daily agricultural wage; measures of the composition of the male labor force; community-level prices; and dummies for survey year. (See Table 1 of the text for descriptions of these variables.) The R^2 obtained from regressing the log of consumption per adult on this set of instruments is .25; when cluster-level consumption averages are included, the R^2 rises to .35.

2/ From Tables 3, 4 and 5.

3/ For each household i, the cluster average of (log) consumption per adult is calculated omitting the consumption level of the household in question.

4/ The confidence band spans two estimated standard deviations above and below the IV estimate.

5/ The estimate is very near the upper bound of the IV confidence band, .104.

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Paper Number 2

Fertility and Child Schooling in Ghana: Evidence of a Quality/Quantity Tradeoff

Raylynn Oliver

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Abstract

Raising the quality of children by increasing school enrollment and lowering high fertility are frequently the goals of public policy in Sub-Saharan Africa. Studies in other parts of the world have found that at a certain stage of the demographic transition, parents begin to reduce the number of children they have in order to increase the investments in each child. Perhaps the most obvious investment in child quality is school enrollment. This paper explores the relation between child schooling and fertility in Ghana, using survey data that include household demographic and economic variables as well as community-level data on the access to schooling, to ascertain whether this "tradeoff" between fertility and child schooling is under way and what policies will most likely encourage it.

The most striking result is the large impact of mother's schooling in lowering fertility and raising child schooling, and the large predicted impact of female secondary schooling, in particular, in rural areas. Increases in household income are also associated with lower fertility and higher child schooling. The results indicate that increases in the fees charged at local schools will raise fertility, but by a very small amount. However, an increase in fees is also associated with *higher* child schooling. The policy implications of these results are, first, that female schooling can be a potent instrument for lowering fertility and raising child school enrollments, and second, that increasing the cost of schooling would not have an important impact on fertility.

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Introduction

Both schooling and fertility have an important impact on a country's economic growth and development. Thus, both have been the object of government and donor programs, especially in developing countries. Increases in school availability and enrollment enrich a country's human capital. Reductions in fertility reduce child and maternal mortality risk. In addition to their impact on economic development, fertility and schooling have an effect on each other.

Because high population growth rates hinder government efforts to increase the quality and accessibility of educational facilities, family planning programs are expected to complement direct attempts to increase schooling by slowing the rate of population growth. On the other hand, increases in schooling also complement family planning program efforts to reduce fertility. Empirical studies show that women who have some schooling have fewer children and are more likely to use contraception.[1] This complementarity, however, is realized only after a lag of several years when the more-schooled women enter their childbearing years.

A second, more immediate, complementarity is suggested by economic models of fertility decision-making. What has come to be called the quality-quantity tradeoff occurs when a woman decides to produce fewer children and make a higher per child investment in those children. If women do make such a tradeoff, then reductions in the price of schooling, one type of quality investment, may induce a substitution away from quantity and to quality. This idea was presented in Becker (1960) to explain the fertility declines observed in developed countries. It may have a more important effect in developing countries where lack of schooling facilities often constrain the tradeoff.

This paper explores the extent of the complementarity between child schooling and fertility in Ghana using survey data that include household demographic and economic variables as well as community level data on the access to schooling. Ghana represents an important case because schooling levels there have been relatively high among African countries since independence yet, like most Sub-Saharan Africa countries, fertility rates remain high and contraceptive usage rates remain low.

The methodology employed follows that used by Montgomery and Kouamé (1993) to explore the existence of a quality-quantity tradeoff using similar data from the neighboring country of Côte d'Ivoire. They find a positive relationship between enrollment rates and cumulative child schooling and fertility in rural areas of Côte d'Ivoire that contrasts with a negative relation in urban areas. In spite of the geographical proximity of the two countries, they differ sharply in overall levels of female schooling and fertility. The data from Ghana also include price of schooling variables that are not available in the Côte d'Ivoire data. Thus the two studies should provide an illuminating picture of the possible existence of a tradeoff.

Section II presents an economic model of fertility and child schooling decisions. Section III describes fertility, schooling levels and the data from Ghana. Section IV discusses the estimation and results. Section V contrasts the results to those from Côte d'Ivoire and other countries, discusses the policy implications and concludes.

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1. Ainsworth (1990), Oliver (1994) and others document this relationship using data from Sub-Saharan Africa.

Economic Model of Fertility and Child Schooling Decisions

Microeconomic models based on the early work of Becker (1960) and Leibenstein (1957) postulate a household choosing the number of children to produce in order to maximize utility subject to its production functions and budget and time constraints. Children are demanded for their contribution to household income and for the utility they provide to their parents. These benefits are weighed against the costs, in time and goods, of raising children. The number of children a household demands is a function of the wealth and income of the household and the prices faced by the household.

Households may also choose to invest more or less in food, clothing, housing, schooling and health care for a child. The quality-quantity models introduce quality as an additional argument in the household's decision, acknowledging that the cost of children can vary substantially according to the investment the household chooses to make in the "quality" of the child. Ignoring the quality aspect of a commodity can lead to biased estimates of the demand for quantity of that commodity and this is expected to hold true for children as it does with other arguments of the household's utility function.[2]

The interest here is in the demand for children. If children were normal goods and if they required a set level of investment, then rich families would demand more children than poor families. That this relationship is not universally observed has been explained by the existence of a quality-quantity tradeoff wherein wealthier families spend more on children not by having more children, but by increasing the level of per child expenditure and often even having fewer children.

The woman maximizes her utility, U, that is a function of the number of children, C, the quality of children, Q, consumption of market goods, X, and leisure, L, and her tastes, μ (equation 1). Children require inputs of the woman's time, T_C, and market goods, X_C. The allocation of the woman's time to market activities, T_M, to child rearing and to leisure may not exceed her total time endowment, Ω (equation 2). Utility is maximized subject to the time allocation constraint and a full income budget constraint (equations 2 and 3). The price of consumer goods, p_X, is multiplied by the sum of market goods for the household and those required for the production of children, and the price of child quality inputs, p_Q, is multiplied by the quality for each child and the number of children. The sum of expenditures must equal the sum of income earned from the sale of time in the market, $w \cdot T_M$ and exogenous income, Y.

$$\max U = U(C, Q, X, L; \mu) \tag{1}$$

$$T_M + C \cdot T_C + L = \Omega \tag{2}$$

$$p_X(X + C \cdot X_C) + p_Q \cdot Q \cdot C = w \cdot T_M + Y \tag{3}$$

The demand for children and the demand for quality can then be expressed as functions of the exogenous variables: prices, p_X and p_Q, wage, w, and exogenous household income, Y.

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2. Theil (1952) discusses the theoretical biases introduced when quality is not taken into account.

$$C = C(p_x, p_Q, w, Y; \mu) \quad (4)$$

$$Q = Q(p_x, p_Q, w, Y; \mu) \quad (5)$$

Both equations will be estimated in the empirical section below. This reduced form approach reflects the fact that both variables, the number of children and the quality of children, are jointly chosen and are a function of the same exogenous variables. The model does not postulate a causal relationship between quantity and quality--households do not choose fewer children because they spend more on schooling nor do they choose more schooling because they have fewer children. Rather both are chosen to maximize utility as constrained by income in face of existing prices.

Consider the expected impact of the exogenous variables on the demand for numbers and quality of children. An increase in the price of other goods will raise the demand for children and quality as women substitute away from purchased consumption goods. However, it will also leave less income to be spent on all inputs to the utility function. Demand for children will also be directly reduced by the increase in the cost of producing children. The presumption is usually made that the substitution effect is smaller than the combined negative income effect and own-price effect and that the net effect of increasing the price of other goods on the demand for children and quality will be negative.

The price of quality is expected to reduce demand for quality; the income and substitution effects work in the same direction. The effect of p_Q on the demand for children is indeterminant. The income effect will be negative, as will the own-price effect, but there will also be an offsetting positive substitution effect.

The effect of a woman's wage on demand for children is theoretically indeterminant. It can also be decomposed into an income and a substitution effect. An increase in the woman's wage increases the cost of producing children. The "own-price" substitution effect on the demand for children is unambiguously negative. However, an increase in women's wages can also raise her income. The effect of the increase in income on the demand for children will depend on whether or not children are normal goods. The net effect is usually found to be negative. The presumed effect of woman's wage on quality, on the other hand, is positive; both the income and substitution effects are expected to be positive.

Holding women's wage and prices constant, an increase in exogenous income is expected to raise the demand for children and quality. Empirical work, however, often shows that increases in income lower demand for children. The expected effects of the exogenous variables on the demand for children and quality are summarized in the signs above equations 6 and 7.

$$\overset{-}{C} = C(\overset{\pm}{p_x}, \overset{-}{p_Q}, \overset{+}{w}, Y; \mu) \quad (6)$$

$$Q = Q(p_X, p_Q, w, Y; \mu) \qquad (7)$$

Montgomery and Kouamé (1993) suggest that if the estimated effect of the individual exogenous variables on the demand for children is opposite to that of its estimated effect on the demand for quality, then that could be taken as evidence of a quality-quantity tradeoff. This reflects the Becker view of quality and quantity as substitutes. In this scenario, fertility may be higher for families who face a higher price of schooling.

However, as the discussion of equations 6 and 7 shows, only the signs of women's wage are expected to be opposite. For example, if child schooling and number of children are complements, and schooling is considered to be an essential input into childrearing, then an increase in the price of schooling might decrease the demand for children so that schooling can be purchased for each child. This view of the importance of the quality/quantity tradeoff in reducing fertility is supported by the evidence from Kenya. Kelley and Nobbe (1990) find that increases in the cost of schooling were partially responsible for the fertility reductions in there.

Several aspects of household decision-making in Sub-Saharan Africa may weaken the predictive power of the neo-classical model presented above. In her analysis of fertility in Kenya, Gomes (1984) finds the assumption of equal per child expenditure to be invalid. She reports that it is common practice for eldest children to be favored with resources to attain an education; younger children will have access to fewer resources until the eldest is able to contribute. In addition to the differences across birth orders, there are substantial differences in the treatment of boys and girls. Primary school enrollment ratios for girls average 15 percent below those for boys in Sub-Saharan Africa (World Bank, 1993a).

The types of investments available to the majority of households in Sub-Saharan Africa also differ from those in developed countries. Where the level of total expenditure is low, a significant portion of the expenditure on children will be spent to achieve a subsistence level of living for the children that is closely tied to that of the parents.

Finally, the economic model discussed above does not allow for the possibility of achieving the demanded quantity or quality of children except by altering fertility behavior and expenditure. In Sub-Saharan Africa child fostering is very common (Ainsworth, 1992). Children are often sent to live with relatives to contribute their labor to the relative's household, to gain access to schools and other opportunities, and, sometimes, to reduce the cost to the parents of raising the children. This efficient and ubiquitous cost- and benefit-sharing mechanism will also attenuate the predictions of the model, but the signs should not be affected.

Fertility and Schooling in Ghana

In order to motivate the empirical specifications and interpret the results presented in Section IV, it is useful to review the context within which fertility and schooling decisions are being made. This section outlines the current levels of fertility and describes the history of population and education policy in Ghana.

Ghana was one of the first Sub-Saharan Africa countries to adopt a comprehensive policy designed to reduce population growth rates (Ghana, 1969). As part of the population policy, a National Family Planning Programme was launched in 1970. It became the focus of the country's efforts to reduce population growth rates. In 1989, Owusu et.al., found "no evidence of any really serious opposition to family planning on political or religious grounds within the country". The adoption of such a policy in Ghana contrasts sharply with the strongly pro-natalist official policies prevailing until only recently in most African countries. As a result, availability and knowledge of modern contraceptives are relatively high.

Contraceptives are widely available in pharmacies and health facilities throughout Ghana. Family planning services are offered at the nearest health facility to 55 percent of the population and at the nearest pharmacy for 81 percent of the households (Ghana Living Standards Survey, 1988-89). Pills can be purchased without a doctor's prescription. Three-quarters of women live within 5 miles of a source of modern contraceptives and 82 percent of the women know of at least one modern method of contraception (Oliver, 1994). Abortions are legal for a broad range of medical, juridical and socioeconomic reasons. The only restrictions are that the approval of the husband is required and that the abortion must be performed by a physician (Scribner, 1994).

In spite of this, family size and total fertility in Ghana remain high and contraceptive use rates remain low. Table 1 presents recent Ghanaian total fertility rates (TFR) calculated by current residence and woman's schooling. There is substantial variation across groups. Women with some secondary schooling in urban areas have a TFR of 3.3 and those with no schooling in rural areas average 7.4. The average across all Ghanaian women is 6.3 far higher than the averages of 2.7, 3.1 and 4.2 in East Asia, Latin America and South Asia, respectively (World Bank, 1993a).

Twenty-seven percent of the women who have cohabited have used a modern method at least once, 33 percent are currently using some kind of contraception, but only 6 percent are currently using a modern method of contraception (Oliver, 1994). This is far below the contraceptive prevalence rates in Western countries and Asian countries, 70 percent and 40 percent respectively, but higher than those prevailing elsewhere in Sub-Saharan Africa. Except for Kenya, Botswana and Zimbabwe, use of *any* method of family planning is below 10 percent for the Sub-Saharan African countries.

Ghana became independent in 1957. After a decade of economic prosperity and an emphasis on education, Ghana became a leader among Sub-Saharan African countries

Table 1: Total Fertility Rates in Ghana, 1987-1989

	Ghana	*Accra/Kumasi*	*Other Urban*	*Rural*
No Education	7.02	5.42	6.14	7.36
1-10 years	5.88	4.23	5.05	6.65
Over 10 years	3.24	3.28	3.70	3.05
All Women	6.25	4.14	5.32	6.96

Note: Total Fertility Rate is the number of children a woman would have if she were to survive all of her child bearing years and bear children at each age at the prevailing age-specific fertility rate. Sample TFR were calculated based on the number of children born in the last five years to women divided into five year cohorts.
Source: Ghana Living Standards Survey, 1987-88 and 1988-89.

in both enrollment and quality of education by the late 1960s.[3] An economic downturn and a dramatic decrease in portion of GNP spent on education caused a significant reversal. By the early 1980s, funds for textbooks were unavailable, the quality of teachers had declined, and a large majority of students completing primary school in rural areas were completely illiterate. Since the low point in 1984, quality and enrollment have begun to improve.

In the Ghanaian school system, after six years of primary schooling, students continue to middle school (grades 7 through 10) or pass an examination that qualifies them to commence secondary school. Primary and middle schools are compulsory, though enrollment is well below 100 percent of school age children. Secondary school consists of five years of study, after which CGE O level exams are taken, and two additional years, after which CGE A level exams are taken. Students who pass A level exams are qualified to enter one of Ghana's three universities. There are also commercial, vocational and teacher training schools.

School enrollment ratios in Ghana are among the highest in Africa, though they are low compared to other countries at similar levels of GNP. Total gross primary and secondary enrollment rates are 73 percent and 39 percent in 1988 compared to 67 percent and 18 percent for all Sub-Saharan Africa.[4] This is after the drop in primary enrollment rates from a high of 80 percent in 1980 that followed the Ghanaian economic crisis and decrease in percent of GNP devoted to education (Tansel, 1992). Primary schools are located in most towns throughout the country; 90 percent of the households are within one mile of a primary school, though the quality of the facilities, supplies and teaching

3. Glewwe (1994) describes the Ghanaian educational system and the quality of inputs in his extensive analysis of the economics of school quality investments.

4. Gross primary enrollment ratios are the ratio of pupils to the population of school-age children. The gross enrollment ratios may exceed 100 percent in countries with universal enrollment because some pupils are younger or older than the country's standard primary school age.

Table 2: Completed Schooling of Women in Ghana

	n	*Mean Years of Schooling*	*Percent with No Schooling*
Age 15-19	788	5.2	32%
Age 20-24	932	5.6	35
Age 25-29	931	5.3	38
Age 30-34	777	5.3	38
Age 35-39	521	4.3	51
Age 40-44	369	3.0	65
Age 45-50	401	1.7	77
All Women	4719	4.7	43%

Source: Ghana Living Standards Survey, 1987-88 and 1988-89.

varies greatly. Seventy percent of the households are within 2 miles of a middle school but only 25 percent are that close to a secondary school.

Tables 2 and 3 describe the levels of schooling reported for women and children in the Ghana Living Standards Survey. The mean years of completed schooling for women age 15 to 50 is 4.7 years. The average is highest for women age 20 to 24 at 5.6 years. The percent of women with no schooling decreases from 77 percent for women over age 44 to 32 percent for women age 15 to 19.

For children age 4 to 30 the mean years of schooling completed is 3.4 years. Among those who have had some schooling but are no longer in school the mean is 7.0 years. The percent currently enrolled is highest for children age 10 and 11, 76 percent, and lowest among children age 20 to 30, 11 percent. The percent never enrolled is highest for children age 4 to 7. Many children do not enter the schools in Ghana until age 7 or 8.

The Ghanaian school system differs from that of Côte d'Ivoire in several respects. Average years of schooling and percentage currently enrolled are both higher in Ghana. Unlike the situation in Côte d'Ivoire, there is very little repeating of grades in Ghana. With the exception of the exam that is required for entry into secondary school, students proceed through the grades regardless of academic progress and grade completed need not reflect skill acquisition.

The data used in this paper are from the two years of the Ghana Living Standards Survey (GLSS). The GLSS was carried out by the Ghana Statistical Service in 1987-88 and again in 1988-1989 with assistance from the World Bank. The Ghana Living Standards Measurement Study data, sample selection strategy and data collection are described in World Bank (1993b). The survey gathered extensive information on household members' health, education, employment, and income. Data were also collected on migration, self-employment, consumption and farming. One woman was selected at random from among the women in the household aged 15-50 to respond to

Table 3: Schooling of Children in Ghana

	n	*Currently Enrolled (percent)*	*Never Enrolled (percent)*	*Stopped (percent)*	*Mean Years Completed (among those who stopped)*
Age 4-7	1946	50.4%	39.6%	10.2%	1.7
Age 8-9	1169	74.3	21.7	3.9	2.3
Age 10-11	897	75.9	18.7	5.4	2.5
Age 12-13	884	71.4	18.8	10.0	3.4
Age 14-15	704	65.3	21.2	13.6	5.0
Age 16-17	580	47.8	22.6	29.8	6.1
Age 18-19	482	33.2	24.3	42.5	7.3
Age 20-30	1218	10.8	25.2	64.0	8.6
All Children	7880	53.2%	20.7%	26.2%	7.0

Source: Ghana Living Standards Survey, 1987-88 and 1988-89.

the fertility section of the questionnaire. Birth history, contraception knowledge and use and the circumstances of the woman's last birth were covered. Over 3,000 households from 200 randomly selected clusters representing all parts of Ghana were surveyed in each year. The 1988-89 survey was supplemented by a school survey that included the primary and middle schools in half of the clusters. Information was gathered on health facilities, school facilities, teacher qualification and, especially useful for this survey, annual and other school fees.

Estimation and Results

The methodology that will be employed is described in detail in Montgomery and Kouamé (1993). Fertility and child schooling decisions are presumed to be made simultaneously, subject to the same set of exogenous variables. The following set of reduced-form equations will be estimated:

$$F = X\beta^1_F + Z\beta^2_F + V\beta^3_F + \mu_F$$

$$S_i = X\beta^1_S + Z\beta^2_S + W_i\beta^3_S + V\beta^3_F + \mu_{Si} \quad \text{for all i children in the household}$$

F is the measure of fertility for an individual woman, S_i is the schooling of the ith child, X, Z and V are characteristics of the woman, her household, and the community, respectively, and W_i are characteristics specific to the individual child.

The first equation is estimated for one woman age 15 to 50 from each household. The complete data set, including economic, employment and expenditure data in addition to household composition, fertility and community information is available for 4,625 women.[5] The S equations are estimated for all of the women's surviving children 5 to 30 years of age at the time of the survey.[6,7]

Two measures of fertility will be estimated. The first, children ever born, measures cumulative fertility, the number of children the woman has given birth to in her lifetime, including those that died shortly after birth. Because women of all ages are included, children ever born does not measure completed fertility. Age must be included to control for how far from completed fertility the women are. And because age must be included for that reason, birth cohort effects cannot be measured separately. Children ever born is a discrete non-negative variable. Ordinary Least Squares (OLS) estimates are not efficient but the results are easily interpretable and do not differ substantially from the predictions of an ordered probit model.

The second measure of fertility measures recent fertility and assumes a value of one if the woman has given birth in the last five years, regardless of whether or not the

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5. Of the 6,328 households surveyed in the 1987-88 and 1988-89 rounds of the GLSS, 25 percent (1,582) did not contain any woman between the ages of 15 and 50. In addition, 121 households were excluded due to irreconcilable discrepancies and missing data.

6. Of the 4,625 women, 964 have never given birth. The survey notes births of 14,774 children. Of these, 12,279 were living and 9,517 were age 4 to 30 at the time of the survey. 1,473 children could not be linked to the schooling data and 164 were excluded due to other missing data. The sample includes the women's children who are living away from the household and excludes children living in the household who have a different mother. The resulting sample includes 7,880 children.

7. There are no schooling equations for women who have had no children. The potential schooling for children of women who currently have no children is not taken into account. Pitt and Rosenzweig (1991) discuss the selection problem and potential selectivity bias associated with these two equations. They find evidence of selectivity but little indication of selectivity bias. No correction for selectivity has been made here.

child survived. Again, age must be included to control for changes in the birth rate of childbearing throughout the life cycle. It is however, a measure of fertility decisions made during a specific historical period for all women. Probit estimates of the binary variable will be compared to OLS estimates of the number of children ever born to the woman.

Similarly, two measures of child schooling are estimated: the years of completed schooling of each individual child and a binary variable for whether the child is currently enrolled in school. Children 4 to 30 years old are included in the sample. As with cumulative fertility, ultimate schooling levels are not known for younger children. Age of the child must be included to control for incomplete schooling. Cumulative schooling will be estimated using OLS and compared to the probit estimates of current school enrollment.

Variable definitions are provided in Table 4 for the sample of women and Table 5 for the sample of children. The household characteristics include the woman's schooling, household consumption expenditure, language of the household head (a proxy for ethnicity) and the woman's age. No data on marital status or spouses are included because marriage decisions are considered to be jointly endogenous to fertility decisions. Location of current residence is divided into five areas: Accra/Kumasi, Other Urban, Rural Coastal, Rural Forest and Rural Savannah. There are important differences in the cost of living and access to social services across areas. Later specifications introduce the availability and cost of schooling in the community. Child specific characteristics include the age and sex of the child.

Household consumption expenditure serves as a proxy for permanent income. It includes all expenditure, an imputed value of rent, the use value of durable goods and the value of consumption of household production.[8] The log of total household expenditure (in cedis) divided by the number of adults (ages 16 and over) in the household, and the square of per adult expenditure are included as explanatory variables.[9] A purely exogenous measure of permanent income is not available. Because of the endogeneity of the consumption, household expenditure and its square are estimated using years of completed schooling and occupational category of the household head. The estimates presented below use the predicted per adult consumption expenditure.

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8. The household expenditure variable includes expenditures on schooling. This introduces a potential correlation. However, schooling expenditures average only 0.2 percent of total household expenditure. Further, because expenditure is included to control for the level of resources available to the households, it would be incorrect to exclude expenditure on schooling.

9. The GLSS defines a household to include "all the people who normally live and eat their meals together in the dwelling for at least three of the last twelve months".

Table 4. Variable Means and Standard Deviations: Sample of Women

Variable	All Women n = 4,625 Mean	Std.Dev.	Rural Women n = 3,054 Mean	Std.Dev.	Urban Women n = 1,571 Mean	Std.Dev.
Dependent Variables						
CHILDREN EVER BORN	3.203	2.818	3.424	2.905	2.773	2.589
BIRTH, LAST 5 YEARS	0.621	0.485	0.660	0.474	0.545	0.498
Woman's Schooling						
NO SCHOOLING	0.433	0.495	0.504	0.500	0.295	0.456
PRIMARY	0.160	0.367	0.167	0.373	0.148	0.355
MIDDLE	0.357	0.479	0.309	0.462	0.451	0.498
SECONDARY	0.050	0.217	0.020	0.141	0.106	0.308
Ln(EXPENDITURE)[a]	11.599	0.267	11.549	0.268	11.695	0.236
Ln(EXP) SQUARED	135.099	6.123	133.920	6.131	137.392	5.417
YEAR1	0.508	0.500	0.487	0.500	0.549	0.498
YEAR2	0.492	0.500	0.514	0.500	0.451	0.498
Current Residence						
ACCRA/KUMASI	0.101	0.302	..	..	0.298	0.457
OTHER URBAN	0.238	0.426	..	..	0.702	0.457
RURAL COAST	0.151	0.358	0.228	0.420	..	..
RURAL FOREST	0.321	0.467	0.486	0.500	..	..
RURAL SAVANNAH	0.189	0.391	0.286	0.452	..	..
Language of household head						
AKAN	0.486	0.500	0.498	0.500	0.463	0.499
EWE	0.159	0.366	0.154	0.361	0.169	0.375
GA	0.075	0.263	0.049	0.216	0.125	0.331
DAGBANI	0.033	0.178	0.036	0.186	0.027	0.161
HAUSA	0.021	0.143	0.005	0.070	0.052	0.222
NZEMA	0.011	0.102	0.010	0.102	0.011	0.103
OTHER	0.215	0.411	0.247	0.431	0.153	0.360
Woman's Age						
AGE15_19	0.166	0.372	0.174	0.379	0.150	0.357
AGE20_24	0.198	0.398	0.200	0.400	0.193	0.395
AGE25_29	0.197	0.398	0.193	0.395	0.205	0.404
AGE30_34	0.165	0.371	0.155	0.362	0.184	0.388
AGE35_39	0.114	0.317	0.107	0.309	0.126	0.332
AGE40_44	0.078	0.268	0.079	0.269	0.076	0.265
AGE45_50	0.084	0.278	0.093	0.290	0.066	0.249

a. The variable used in the estimation is the log of per adult household expenditure. The mean level of total household expenditure is 313,600 cedis, approximately $1,363.

Table 5. Variable Means and Standard Deviations: Sample of Children

Variable	All Children n = 7880 Mean	Std.Dev.	Rural Children n = 5,384 Mean	Std.Dev.	Urban Children n = 2,496 Mean	Std.Dev.
Dependent Variables						
GRADES COMPLETED	3.373	3.958	3.124	3.868	3.910	4.095
ENROLLED IN SCHOOL	0.532	0.499	0.483	0.500	0.638	0.481
Mother's Schooling						
NO SCHOOLING	0.569	0.495	0.627	0.484	0.443	0.497
PRIMARY	0.142	0.349	0.140	0.347	0.146	0.353
MIDDLE	0.261	0.439	0.218	0.413	0.353	0.478
SECONDARY	0.029	0.167	0.015	0.121	0.058	0.234
Ln(EXPENDITURE)[a]	11.606	0.264	11.569	0.263	11.686	0.249
Ln(EXP) SQUARED	135.269	6.034	134.379	5.971	137.189	5.716
YEAR1	0.498	0.500	0.482	0.500	0.534	0.499
YEAR2	0.502	0.500	0.518	0.500	0.466	0.499
Current Residence						
ACCRA/KUMASI	0.081	0.274	..	..	0.257	0.437
OTHER URBAN	0.235	0.424	..	..	0.743	0.437
RURAL COAST	0.147	0.355	0.216	0.411	..	..
RURAL FOREST	0.349	0.477	0.511	0.500	..	..
RURAL SAVANNAH	0.187	0.390	0.273	0.446	..	..
Language of household head						
AKAN	0.483	0.500	0.508	0.500	0.428	0.495
EWE	0.160	0.367	0.152	0.359	0.178	0.383
GA	0.063	0.244	0.039	0.194	0.115	0.320
DAGBANI	0.030	0.170	0.030	0.171	0.028	0.166
HAUSA	0.030	0.170	0.008	0.088	0.077	0.267
NZEMA	0.011	0.103	0.011	0.106	0.010	0.098
OTHER	0.224	0.417	0.252	0.434	0.163	0.369
Child's Age and Sex						
FEMALE	0.479	0.500	0.473	0.499	0.492	0.500
MALE	0.521	0.500	0.527	0.499	0.508	0.500
AGE 5_7	0.247	0.431	0.249	0.433	0.242	0.428
AGE 8_9	0.148	0.355	0.149	0.356	0.147	0.355
AGE 10_11	0.114	0.318	0.111	0.314	0.121	0.326
AGE 12_13	0.112	0.317	0.112	0.316	0.112	0.316
AGE 14_15	0.089	0.285	0.086	0.280	0.097	0.297
AGE 16_17	0.074	0.261	0.075	0.263	0.071	0.256
AGE 18_19	0.061	0.240	0.059	0.235	0.067	0.250
AGE 20_30	0.155	0.362	0.160	0.367	0.143	0.350

a. The variable used in the estimation is the log of per adult household expenditure. The mean level of total household expenditure is 313,600 cedis, approximately $1,363.

The observation is often made that household decisions vary substantially between urban and rural areas. This was found to be true in Ghana for contraceptive use and fertility decisions (Oliver, 1994) and by Montgomery and Kouamé (1993) in their analysis of the Quality/Quantity tradeoff in Côte d'Ivoire. Estimations are presented for the entire sample and then urban and rural sub-samples are estimated separately. Tests for statistically significant differences will be made. Means and standard deviations for the urban and rural sub-samples are also provided in Tables 4 and 5.

Baseline Results

The estimation results for the full sample of women and their children are presented in Table 6. Schooling of the woman has a significant impact on both fertility and child schooling. Women with secondary schooling have an estimated 1.1 fewer children than women with no schooling. Children whose mothers have some secondary schooling have an estimated 0.9 years more schooling than those whose mothers have no schooling. These are large differences when compared to sample means of 3.2 children and 3.4 years of school. The impact of any middle school is just under half as large as the impact of secondary school in the cumulative fertility estimate. The relative effect is smaller for cumulative schooling but nearly equal for current enrollment. Primary schooling has a much smaller impact on cumulative fertility and has no significant impact on current fertility. Children whose mothers have some primary schooling are significantly more likely to be enrolled in school but there is no significant difference in cumulative schooling between children whose mothers have some primary schooling and those whose mothers have no schooling.

Predicted annual household per adult expenditure and its square have a significant effect on both cumulative and current fertility. The estimated impact on cumulative fertility is positive except for households in the highest three expenditure deciles. The estimated impact on current fertility is positive except for household whose expenditure falls among the richest 15 percent of households.

The expenditure-child schooling relation is also not straightforward. The coefficients on expenditure and expenditure squared are significant in estimates of both cumulative and current schooling. The combined impact is positive for all households for both dependent variables. Coefficients on current residence reveal significant differences in both fertility and child schooling across areas. The reference group is women, or children, in the rural savannah. Women in Accra/Kumasi have 0.4 fewer predicted children, women in other urban areas have 0.3 fewer children. There is no predicted difference across the three rural regions. Recent fertility is significantly lower for all urban, semi-urban, coastal and forest women than for women in the rural savannah.

Predicted child schooling is lower for children in Accra/Kumasi than for children in the rural savannah. It is also lower in the rural forest and coastal regions. The estimated coefficients on current enrollment follow the same pattern.

Akan, the omitted language group, accounts for nearly half of the sample. Cumulative fertility is lower for all other language groups except one; Hausa women have predicted children ever born 0.3 higher than Akan women. The predicted coefficients on the language group variables in the current fertility equation are insignificant. It appears that women in all groups have children at approximately the same rate, Hausa women continue longer than other women and, as a result, have higher cumulative fertility. Interacting Hausa with the age categories removes the significance from the Hausa coefficient and replaces it with a significant coefficient on age 40-44 and age over 44 for Hausa women.

Table 6. Cumulative and Current Fertility and Schooling Models: Baseline Results, Full Sample

	Women				*Children*			
	Children Ever Born OLS		*Birth last 5 years Probit*		*Years of Schooling OLS*		*Current Enrollment Probit*	
Variable	*β*	*t*	*β*	*t*	*β*	*t*	*β*	*t*
Woman's Schooling								
PRIMARY	-0.139	-2.055	-0.096	-1.361	-0.086	-0.633	0.100	1.732
MIDDLE	-0.498	-8.948	-0.178	-2.909	0.248	1.995	0.366	6.817
SECONDARY	-1.083	-9.788	-0.662	-5.372	0.915	2.859	0.512	3.090
Ln(EXPEND)	28.938	3.569	42.988	4.888	49.820	3.085	26.724	3.769
Ln(EXP) SQ	-1.233	-3.529	-1.807	-4.771	-1.934	-2.839	-1.047	-3.508
YEAR1	0.513	3.711	0.868	5.782	1.952	4.786	1.138	6.037
Current Residence								
ACCRA/KUMASI	-0.415	-3.694	-0.868	-7.500	-0.814	-2.135	-0.299	-1.548
OTHER URBAN	-0.267	-2.721	-0.606	-6.052	-0.195	-0.674	-0.137	-0.936
RURAL COAST	0.024	0.249	-0.451	-4.287	-1.282	-3.493	-0.571	-3.252
RURAL FOREST	0.100	1.073	-0.365	-3.810	-0.595	-1.854	-0.478	-3.111
Language of household head								
EWE	-0.194	-2.988	0.024	0.361	-0.439	-2.312	-0.257	-3.587
GA	-0.296	-3.555	0.113	1.177	-0.281	-1.625	-0.330	-3.887
DAGBANI	-0.344	-2.809	0.139	0.966	-3.008	-7.978	-1.359	-6.198
HAUSA	0.278	1.494	-0.037	-0.250	-0.126	-0.402	0.141	0.964
NZEMA	-0.104	-0.638	-0.155	-0.722	-0.381	-1.304	-0.262	-0.949
OTHER	0.065	0.917	0.354	4.636	-0.661	-3.495	-0.177	-2.109
Woman's Age								
AGE20_24	1.046	12.892	1.275	12.547				
AGE25_29	2.287	19.917	1.533	11.742				
AGE30_34	3.628	27.511	1.351	9.624				
AGE35_39	4.736	35.633	1.049	8.452				
AGE40_44	5.963	42.460	0.588	5.754				
AGE45_50	6.650	43.967	0.235	2.253				
Child's Age and Sex								
MALE					1.077	12.851	0.348	9.443
AGE 8_9					0.531	5.756	0.700	13.832
AGE 10_11					1.471	14.074	0.837	13.630
AGE 12_13					2.438	16.631	0.669	9.810
AGE 14_15					3.872	19.881	0.965	8.664
AGE 16_17					5.287	20.427	0.521	4.505
AGE 18_19					5.973	20.140	0.130	1.128
AGE 20_30					6.511	22.847	-0.751	-7.482
Constant	-168.590	-3.592	-255.103	-5.009	-316.576	-3.317	-169.163	-4.024
R^2		0.654		0.258		0.351		0.261
Likelihood				-2321.55				-4024.69
n		4625		4625		7880		7880

1. Excluded categories: No schooling, Rural Savannah, Akan language, Woman's age 15-19, Child's age 5-7, Child's sex female.

The estimations of child schooling reveal striking differences across language groups. Dagbani children have 3.0 years fewer predicted schooling than Akan children, an important difference on a variable with mean 3.4. Ewe and Ga children have 0.4 and 0.3 years less predicted schooling, respectively. Current schooling estimates are similar, children from all non-Akan speaking households are less likely to be currently enrolled in school.

Male children have predicted schooling 1.1 years higher than their female counterparts and are more likely to be currently enrolled. Predicted cumulative schooling increases at a decreasing rate as the child's age increases. This is as expected. Predicted current enrollment increases through age 15 and then declines.

The estimations presented in Table 6 provide some evidence of a quality-quantity tradeoff. This is especially true of the woman's schooling variables that exert a significant positive impact on child schooling and a significant negative impact on fertility. Household expenditure has a positive predicted impact on schooling for all households and a negative impact on fertility for the wealthiest households. The negative fertility-expenditure relation among the wealthy households is not seen in the Côte d'Ivoire analysis. To this point it is possible to say only that some of the results are consistent with a tradeoff but the evidence is not overwhelming.

Baseline Results for Urban and Rural Samples

The results presented above provide a basic understanding of the relation between the independent variables and fertility and child schooling. However, F-tests indicate that the hypotheses that the estimated relations are the same for urban and rural women can be rejected for all four dependent variables at the 1 percent level. Table 7 presents the estimation results for the same set of variables for rural women only. Results for urban women are presented in Table 8.

For rural women, primary schooling for the woman has no significant impact on fertility. The predicted impact of middle schooling on cumulative fertility is -0.4 for rural women and slightly higher, -0.6, for urban women. The impact of secondary schooling is similar for both sub-samples: -1.2 and -1.1 for rural and urban women, respectively.

The predicted effect of woman's secondary schooling on years of child schooling is much stronger for rural children, 1.6 compared to 0.5 for urban women. Primary school has no significant impact on cumulative child schooling for either group of women. All levels of schooling increase significantly the probability of current enrollment of children in rural areas; only middle schooling has a significant impact in urban areas.

Table 7. Cumulative and Current Fertility and Schooling Models: Baseline Results, Rural Sample

	Women				*Children*			
	Children Ever Born OLS		*Birth last 5 years Probit*		*Years of Schooling OLS*		*Current Enrollment Probit*	
Variable	*β*	*t*	*β*	*t*	*β*	*t*	*β*	*t*
Woman's Schooling								
PRIMARY	-0.112	-1.378	-0.055	-0.635	-0.170	-1.208	0.168	2.247
MIDDLE	-0.429	-6.306	-0.144	-1.878	0.108	0.757	0.329	4.752
SECONDARY	-1.167	-6.806	-0.856	-3.917	1.622	3.328	0.578	1.790
Ln(EXPEND)	47.257	3.988	50.909	3.914	25.882	1.545	14.227	1.630
Ln(EXP) SQ	-1.990	-3.893	-2.138	-3.806	-0.986	-1.398	-0.506	-1.374
YEAR1	0.920	4.776	0.999	4.756	0.573	1.270	0.869	3.532
Current Residence								
RURAL COAST	-0.274	-2.495	-0.608	-4.962	-0.784	-2.194	-0.620	-2.806
RURAL FOREST	-0.219	-2.023	-0.497	-4.403	-0.168	-0.505	-0.617	-3.122
Language of household head								
EWE	-0.234	-2.880	0.116	1.309	-0.323	-1.671	-0.254	-2.470
GA	-0.311	-2.548	0.179	1.229	-0.412	-1.781	-0.462	-3.310
DAGBANI	-0.444	-2.969	0.035	0.190	-2.102	-7.672	-1.479	-4.713
HAUSA	-0.175	-0.309	-0.589	-1.679	-0.102	-0.167	0.213	0.715
NZEMA	-0.118	-0.617	0.042	0.156	0.232	0.841	-0.222	-0.684
OTHER	0.058	0.654	0.336	3.477	-0.691	-3.317	-0.355	-2.946
Woman's Age								
AGE20_24	0.910	8.817	1.288	9.877				
AGE25_29	2.087	14.099	1.397	8.219				
AGE30_34	3.532	20.853	1.127	6.200				
AGE35_39	4.819	28.544	1.023	6.339				
AGE40_44	6.108	35.983	0.628	4.939				
AGE45_50	6.892	38.552	0.187	1.452				
Child's Age and Sex								
MALE					0.818	8.808	0.309	6.406
AGE 8_9					0.505	4.719	0.764	12.294
AGE 10_11					1.352	10.781	0.931	12.032
AGE 12_13					2.245	13.835	0.832	10.088
AGE 14_15					3.450	14.627	0.862	8.315
AGE 16_17					4.641	14.037	0.652	4.319
AGE 18_19					5.194	13.701	0.309	2.087
AGE 20_30					5.543	15.482	-0.503	-3.702
Constant	-278.650	-4.067	-302.228	-4.022	-166.326	-1.674	-97.121	-1.880
R^2		0.677		0.261		0.312		0.197
Likelihood				-1487.48				-2998.06
n		3054		3054		5384		5384

1. Excluded categories: No schooling, Rural Savannah, Akan language, Woman's age 15-19, Child's age 5-7, Child's sex female.

Table 8. Cumulative and Current Fertility and Schooling Models: Baseline Results, Urban Sample

	Women				*Children*			
	Children Ever Born OLS		*Birth last 5 years Probit*		*Years of Schooling OLS*		*Current Enrollment Probit*	
Variable	*β*	*t*	*β*	*t*	*β*	*t*	*β*	*t*
Woman's Schooling								
PRIMARY	-0.258	-2.109	-0.231	-1.809	0.051	0.230	0.003	0.027
MIDDLE	-0.603	-6.287	-0.251	-2.428	0.213	1.512	0.426	4.025
SECONDARY	-1.066	-7.360	-0.623	-3.885	0.544	1.564	0.161	0.731
Ln(EXPEND)	11.718	1.078	34.128	2.829	15.148	0.739	30.845	2.415
Ln(EXP) SQ	-0.549	-1.172	-1.442	-2.784	-0.543	-0.630	-1.204	-2.246
YEAR1	0.003	0.013	0.727	3.283	-0.053	-0.102	1.531	5.029
Current Residence								
OTHER URBAN	0.203	2.481	0.289	3.243	0.264	1.344	0.330	2.239
Language of household head								
EWE	-0.118	-1.093	-0.128	-1.231	-0.468	-2.536	-0.349	-2.860
GA	-0.117	-1.066	0.073	0.547	-0.263	-1.472	-0.071	-0.494
DAGBANI	-0.280	-1.203	0.276	1.189	-1.624	-2.420	-1.070	-3.841
HAUSA	0.268	1.333	0.005	0.030	-0.183	-0.618	0.292	1.808
NZEMA	0.045	0.158	-0.486	-1.388	-1.076	-2.946	-0.814	-2.622
OTHER	0.105	0.881	0.409	3.231	-0.444	-1.861	0.153	1.197
Woman's Age								
AGE20_24	1.201	9.464	1.278	7.477				
AGE25_29	2.617	14.751	1.801	8.527				
AGE30_34	3.815	18.360	1.743	7.599				
AGE35_39	4.616	21.887	1.167	5.708				
AGE40_44	5.600	22.482	0.523	2.862				
AGE45_50	5.988	21.214	0.376	1.958				
Child's Age and Sex								
MALE					0.654	5.525	0.221	2.988
AGE 8_9					0.813	5.127	0.830	8.907
AGE 10_11					1.816	10.190	0.904	9.044
AGE 12_13					3.027	11.622	0.641	5.209
AGE 14_15					4.242	12.410	0.696	5.430
AGE 16_17					5.283	12.336	0.655	3.228
AGE 18_19					6.162	13.948	0.095	0.501
AGE 20_30					7.251	15.427	-0.792	-4.989
Constant	-61.487	-0.976	-202.559	-2.888	-101.817	-0.838	-196.373	-2.587
R^2		0.606		0.253		0.358		0.210
Likelihood				-813.242				-1244.34
n		1571		1571		2496		2496

1. Excluded categories: No schooling, Other Urban, Akan language, Woman's age 15-19, Child's age 5-7, Child's sex female.

Household expenditure has a predicted negative impact on cumulative fertility for all women in both sub-samples. The predicted impact on recent fertility is positive for all but the wealthiest households. Predicted cumulative schooling and current enrollment increase with household expenditure for rural and urban children. The predicted difference in cumulative schooling between the richest and poorest households is 4.4 years in rural households and 3.3 years for urban households. The male-female differential is larger in rural areas; boys have 0.8 years higher predicted cumulative schooling. Both the rural and urban regressions, provide evidence of a tradeoff between child schooling and fertility is supported by the coefficients on women's schooling and household expenditure.

The results of the Probit estimations are more easily interpreted in Table 9. Average predicted probabilities are calculated for each schooling, residence, and language of household head category using the recent fertility and current enrollment results for rural and urban sub-samples.

Estimates Including the Price of Schooling

The baseline results provide some evidence of a quality-quantity tradeoff. To explore the issue further, specific measures of the cost of schooling are included in the estimations presented in Table 10. The first is a binary variable for the presence of a primary school in the community, the second is the mean annual school fee for the third year of primary school among primary schools in the community, and the third is a binary variable for whether or not there are textbooks in the community primary school. The school data were collected for only a sub-sample of the rural clusters. The average annual fee charge differs from the measure used in the Montgomery and Kouamé analysis. They use actual expenditure per child to compute a price of schooling. The measure included in this analysis is the actual fee charged by schools as collected in the school facility survey.

If there is a quality-quantity tradeoff occurring in fertility and schooling decisions, the price of schooling should be positively related to fertility and negatively related to schooling, the presence of a school should be lower fertility and raise schooling, and the quality should lower fertility and raise schooling.

The quantity/quality hypothesis is partially borne out by the estimations. The annual fee does have a significant positive impact on both cumulative and recent fertility but it also has a significant positive impact on schooling. The quality has no significant predicted effect on fertility but has a significant positive effect on child schooling.

Table 9. Predicted Probabilities of Recent Fertility and Current Enrollment: Urban and Rural Samples

	Rural		Urban	
	Birth last 5 years	*Current Enrollment*	*Birth last 5 Years*	*Current Enrollment*
Woman's Schooling				
NONE	0.676	0.448	0.608	0.593
PRIMARY	0.661*	0.500	0.539	0.594*
MIDDLE	0.636	0.549	0.533	0.708
SECONDARY	0.416	0.623	0.417	0.639*
Current Residence				
ACCRA/KUMASI	..	..	0.482	0.564
OTHER URBAN	..	..	0.570	0.653
RURAL COAST	0.752	0.609	..	..
RURAL FOREST	0.589	0.438	..	..
RURAL SAVANNAH	0.622	0.439	..	..
Language of household head				
AKAN	0.626	0.538	0.528	0.649
EWE	0.659*	0.458	0.488*	0.555
GA	0.676*	0.394	0.550*	0.631*
DAGBANI	0.636*	0.138	0.611*	0.347
HAUSA	0.444*	0.602*	0.530*	0.721
NZEMA	0.638*	0.468*	0.377*	0.420
OTHER	0.717	0.427	0.649	0.688*
Child's Sex				
FEMALE	..	0.431	..	0.604
MALE	..	0.524	..	0.663

Notes: Predicted probabilities are calculated using the current fertility and current enrollment regressions presented in Tables 7 and 8 and the formula: $\hat{p} = (1/N) \sum_{i=1 \text{ to } N} \Phi(\Sigma_{j \neq k} x_{ij} \hat{\beta}_j + \hat{\beta}_k)$ where k refers to the covariate in question. Predicted values are calculated for all women in each sub-sample as if they were all in each of the different categories, in turn, and the average is then calculated over all women.

* Contrast to the omitted category is not statistically significant.

Table 10. Cumulative and Current Fertility and Schooling Models: Including the Price of Schooling, Rural Sample

	Women				*Children*			
	Children Ever Born OLS		*Birth last 5 years Probit*		*Years of Schooling OLS*		*Current Enrollment Probit*	
Variable	*β*	*t*	*β*	*t*	*β*	*t*	*β*	*t*
Woman's Schooling								
YEARS	-0.060	-3.728	-0.036	-2.211	-0.032	-0.563	0.041	2.858
Ln(EXPEND)	73.298	3.026	83.994	3.915	90.292	1.558	42.967	2.880
Ln(EXP) SQ	-3.108	-2.980	-3.547	-3.852	-3.648	1.524	-1.739	-2.791
Price of Schooling								
PRIMARY SCH	-0.033	-0.200	-0.076	-0.432	-0.208	-0.459	-0.061	-0.459
ANNUAL FEE	0.004	3.546	0.004	3.230	0.004	1.558	0.002	2.523
TEXTBOOKS	-0.157	-0.411	-0.047	-0.057	2.749	3.371	1.665	2.781
Current Residence								
RURAL COAST	-0.289	-0.951	-0.897	-3.217	-2.259	-1.696	-1.068	-3.349
RURAL FOREST	-0.345	-1.240	-0.654	-1.989	-0.877	-0.688	-0.635	-2.161
Language of household head								
EWE	-0.269	-1.089	0.229	0.892	-0.753	-1.191	-0.190	-1.233
GA	-0.878	-2.417	-0.359	-1.042	-0.249	-0.215	-0.541	-1.840
DAGBANI	0.098	0.218	0.806	0.861	..	..	..	..
HAUSA	-2.035	-1.556	-1.574	-2.043	0.141	0.089	-0.342	-0.536
OTHER	0.723	2.805	0.903	2.956	-0.179	-0.273	0.003	0.015
Woman's Age								
AGE20_24	1.016	4.402	1.642	5.400				
AGE25_29	2.054	5.377	1.376	3.326				
AGE30_34	3.638	8.128	1.218	2.823				
AGE35_39	4.766	10.666	1.194	3.620				
AGE40_44	6.095	14.381	0.679	2.729				
AGE45_50	6.632	14.690	0.264	0.920				
Child's Age and Sex								
MALE					1.436	4.649	0.228	2.452
AGE 8_9					0.826	2.565	0.876	6.220
AGE 10_11					1.565	4.235	0.927	5.786
AGE 12_13					1.449	4.321	0.529	3.465
AGE 14_15					2.855	4.965	0.678	3.602
AGE 16_17					3.800	4.179	0.676	2.450
AGE 18_19					3.741	4.032	-0.065	-0.211
AGE 20_30					4.097	4.970	-0.566	-2.217
Constant	-430.318	-3.067	-496.219	-3.980	-557.264	-1.592	-265.96	-2.980
R^2		0.645		0.299		0.193		0.254
Likelihood				-262.10				-522.99
n		592		592		1012		1012

1. Excluded categories: No schooling, Rural Savannah, Akan language, Woman's age 15-19, Child's age 5-7, Child's sex female.

Conclusion

Raising the quality of children by increasing school enrollment and decreasing high fertility are frequently the goals of public policy in Sub-Saharan Africa. This paper has explored the possible interaction between household fertility and child schooling decisions suggested by the hypothesis of a quality-quantity tradeoff. Some evidence of the existence of a quality-quantity tradeoff in fertility and child schooling decisions in Ghana is provided by the empirical results.

The most striking result is the statistically significant and large impact the schooling of the mother has on both fertility and child schooling. Women with secondary schooling have 1.1 fewer children than women with no schooling and children of women with secondary schooling have 0.9 years more schooling than children of women who have no schooling. Increasing female enrollment can be expected to raise child schooling and lower fertility. Beyond the contrasting signs on the mother's schooling and location of current residence, the support of the quality-quantity tradeoff is limited.

The predicted impact of schooling is seen in both the urban and rural sub-samples with some subtle differences. Availability of primary school does not have a significant impact in rural areas on either fertility or child schooling. This result may be due to lack of variation as primary schools are widely accessible. On the other hand, secondary schooling of the mother has a much larger predicted impact on child's schooling in rural areas. The male-female schooling differential is somewhat more marked in rural areas.

The price of schooling variable does exert a statistically significant impact on fertility, but the magnitude of the effect is small. A ten percent decrease in the annual fee from the mean reduces the predicted children ever born by only 0.06 children. The impact of the annual fee on child schooling is also positive. This may be because fees are higher in communities where demand for schooling is higher. The presence of a primary school does not significantly affect fertility or schooling. Quality of local schools has a significant positive effect.

In their analysis of Côte d'Ivoire, Montgomery and Kouamé find sharp differences across urban and rural areas that are not present in Ghana. They also tentatively assert that there is no evidence that increases in school costs would raise fertility. While the predicted impact in Ghana is statistically significant, it is small.

The policy implications are two-fold. The first is that female schooling can be a potent instrument for lowering future fertility and raising future school enrollment. The second is that, even though there is some evidence of a tradeoff at work between the number of children and the schooling of those children, increasing the cost of schooling would not be expected to induce a large increase in fertility. Indeed, changing school costs would not have an important impact on fertility.

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